ENERGY & GENDER

An assessment on gender equality in the energy sector in Brazil

Report commissioned by the British Embassy Brasilia in collaboration with the UK Government's Prosperity Fund: Energy Programme.

FINAL REPORT

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HEADLINES

- The energy sector is one of the worst sectors in Brazil in terms of gender equality. Severe inequalities were identified across the entire sector. There is a lack of a gender perspective in the hiring and promotion processes, and little involvement of women in energy access projects at the community level.
- Although women's participation in the job market has been increasing, they are still underrepresented and their progression within their institutions remains an issue. Despite the fact that, on average, women hold more academic qualifications than men, women's salaries are 77.5% lower than men's.
- Brazil faces important challenges to ensure gender equality in the energy sector. Data collected suggest that Brazil's longstanding experience in energy does not translate into gender equality. The sector presents a substantial distortion with only 11,21% women's participation in Executive Boards, 11,85% in Boards of Directors, and 18,18% in Supervisory Boards.
- Women in leading roles are exceptions in the energy sector. The proportion of women with academic background in energy-related courses, such as engineering degrees, is lower than men, whereas the number of women in decision-making positions are much lower, and very rare in CEO positions. In contrast, several cases show that more diversity leads to higher profits for companies.
- Affirmative actions on gender equality are fundamental to speed up the process of increasing women's participation in the energy sector. These include capacity building programmes, awareness campaigns, cultural changes, legal enforcement, targets or quota systems, continuous monitoring, and women's empowerment initiatives. Otherwise, it may take many decades to gradually reduce the inequalities under a business-as-usual scenario.
- Policy support for social projects such as "*Minha Casa Minha Vida"* (My House, My Life) and "*Luz para Todos*" (Light for All), both assessed in this report, are essential. Therefore, the success of these initiatives are also dependant on political will. The UK Prosperity Fund's Energy Programme could support further investments in initiatives alike, share experiences and provide technical support, whilst also increasing awareness of policy makers.
- The lack of recognition and awareness of this exclusion results in absence of appropriate policies and monitoring of existing programmes. There is a lack of disaggregated data by gender, and an absence of gender policies for hiring and promotion. In the private sector, the scenario is even worse for women, given that gender inequality is often not acknowledged as a problem and, therefore, there is a strong resistance to the implementation of affirmative action programmes.
- Most of the gender equality actions in the energy sector in Brazil are informative awareness campaigns and discussion groups or based on leadership initiatives that might end when the person in charge is replaced. There is a need for effective actions/policies and indicators, which are further discussed in this report.

EXECUTIVE SUMMARY

This report focuses on gender equality in the energy sector, both public and private sectors, on how gender inequality impacts women, and how their presence in decision-making can lead to more diverse and better practices that can positively influence transition towards inclusive and successful clean energy paradigm. It also considers the development of a gender-responsive approach to designing opportunities for women in energy technology and innovation. Successful best practices in Brazil and abroad are presented, with the potential to be disseminated and replicated.

This assessment was carried out through literature review, surveys and interviews, including online questionnaires and in-person meetings with several representatives from the energy sector in Brazil, as well as international comparative analysis, including country-level case studies and the UN Sustainable Development Goals (SGDs).

Recent research shows that women's equality is economically important. According to Woetzel *et al*. (2015), US$ 12 trillion could be added to global GDP by 2025 by improving gender equality. In general, women are underrepresented in technological fields and decision-making positions, and receive lower salaries in most jobs in Brazil. Gender inequality continues to hold back women from reaching higher positions in companies and public sectors. Women's participation in decision-making is fundamental to transform Brazil into a nation in which equal rights are not only a constitutional statement, but also a reality.

Moreover, gender inequality means the industry is less open to new ideas, in particular the move to a lower-carbon energy market. The International Renewable Energy Agency's annual review on the sector's jobs (IRENA, 2019) showed that gender discrimination in the field of renewable energy is less pronounced than in the energy sector more broadly. The report also presented some of the main challenges to employment and promotion, such as: flexibility in workplace; mentorship and training; support for parenting; fair and transparent processes; and equal pay and targets for diversity. Brazil's recent increase in renewable energy alternatives such as wind, solar and biomass presents a favourable prospect for improving gender equality. For instance, solar PV (photovoltaics) is expected to increase 122% in the coming years. This is a great opportunity for gender equality, if adequate policies are in place targeting women workforce. In addition, lower costs from solar PV and wind, and decreasing costs of renewable energy technologies will represent a major energy policy shift, bringing more competitiveness and different power generation options. In contrast, the oil and gas sector rank second in gender inequality globally, only behind the construction industry. In the European Energy Sector, for instance, women only represent between 8% and 15% of the total workforce, the majority of women staff work on administrative and sales functions, with only a small percentage occupying senior and mid-management positions.

Our study indicates two shortcomings at the government level that hinders the design and monitoring of policies for gender equality: lack of data disaggregated by gender, and absence of gender policies. Among the affirmative actions included in this study, we assessed the Permanent Committe on Gender, Race and Diversity Issues (Cogemmev) at the Ministry of Mines and Energy (MME), with the charge of analysing the situation and proposing objective actions, and the social programmes "Minha Casa Minha Vida" (My House, My Life) and "*Luz para Todos*" (Light for All) which provide renewable energy for low income families, particularly the families led by women.

This report indicates that overcoming barriers for gender issues in the energy sector requires not only recognition of the baseline or the current situation in the country, but also a good monitoring of indicators, in order to identify the problem and support public policies, companies and NGOs' project management. Both quantitative and qualitative indicators are relevant to appraise the level of success and efforts allocation. This report also suggests actions, indicators and recommendations for gender equality in the energy sector in Brazil.

SUMÁRIO EXECUTIVO

O presente relatório trata da igualdade de gênero no setor energético, tanto no setor público quanto no privado, os impactos sobre as mulheres e como sua presença na tomada de decisões pode influenciar melhores práticas para a diversidade, apoiando uma transição inclusiva para uma economia de baixo carbono. Também trata do desenvolvimento de uma abordagem sensível às questões de gênero na criação de oportunidades para mulheres em tecnologia de energia e inovação. São apresentadas boas práticas de sucesso no Brasil e no exterior, com potencial para serem disseminadas e replicadas.

Essa avaliação foi realizada por meio de revisão de literatura, pesquisas e entrevistas, incluindo questionários on-line e encontros presenciais com vários representantes do setor de energia no Brasil, bem como análise comparativa internacional, incluindo estudos de caso em nível nacional e os Objetivos de Desenvolvimento Sustentável da Organização das Nações Unidas.

Pesquisas recentes mostram que a igualdade de gênero também é economicamente importante. Conforme Woetzel *et al*. (2015), US$ 12 trilhões poderiam ser adicionados ao PIB global até 2025, melhorando a igualdade de gênero. Em geral, as mulheres estão sub-representadas nos campos tecnológicos e nos cargos de decisão e recebem salários mais baixos na maioria dos empregos no Brasil. A desigualdade de gênero continua a manter as mulheres atrás das oportunidades nas posições mais altas nas empresas e no setor público. A falta de reconhecimento e conscientização dessa exclusão resulta na ausência de políticas apropriadas e no acompanhamento dos programas existentes. A participação das mulheres no processo decisório é fundamental para transformar o Brasil em um país onde a igualdade de direitos não seja apenas uma questão constitucional, mas também uma realidade.

Além disso, a desigualdade de gênero significa que a indústria está menos aberta a novas ideias, em particular à mudança para um mercado de energia de baixo carbono. O relatório anual da Agência Internacional de Energia Renovável sobre os empregos na área de energia (IRENA, 2019) mostrou que a discriminação de gênero em energia renovável é menos pronunciada do que no setor de energia como um todo. O relatório também apresentou alguns dos principais desafios ao emprego e à promoção, tais como: flexibilidade no local de trabalho; orientação e treinamento; suporte parental; processos justos e transparentes; e igualdade de remuneração e metas para a diversidade. O recente aumento do Brasil em renováveis, como eólica, solar e biomassa, apresenta uma perspectiva favorável para melhorar a igualdade de gênero. Por exemplo, a energia solar fotovoltaica (PV) deverá aumentar em 122% nos próximos anos. Esta é uma grande oportunidade para a igualdade de gênero, se as políticas corretas estiverem em vigor visando a força de trabalho das mulheres. Além disso, os custos mais baixos da energia solar fotovoltaica e eólica e a redução dos custos de eletricidade das energias renováveis como um todo representarão uma grande mudança na política energética, trazendo mais competitividade de diferentes opções de geração de energia. Em contraste, o setor de petróleo e gás ocupa o segundo lugar em termos de desigualdade de gênero no mundo, atrás apenas do setor de construção civil. No Setor Energético Europeu, por exemplo, as mulheres representam apenas entre 8% e 15% do total da força de trabalho, a maioria do pessoal feminino trabalha em funções administrativas e de vendas, com apenas uma pequena porcentagem ocupando posições de alta e média gerência.

Nosso estudo indica duas deficiências em nível governamental que dificultam a concepção e o monitoramento de políticas para a igualdade de gênero: falta de dados desagregados por gênero e ausência de políticas de gênero. Entre as ações afirmativas incluídas neste estudo, avaliamos o

Comitê Permanente para Questões de Gênero, Raça e Diversidade (Cogemmev) do Ministério de Minas e Energia (MME), responsável por analisar a situação e propor ações objetivas, e os programas sociais “Minha Casa Minha Vida” e “Luz para Todos”, que fornecem energia renovável para famílias de baixa renda, particularmente as famílias chefiadas por mulheres.

Este relatório indica que a superação de barreiras para questões de gênero no setor energético requer não apenas o reconhecimento da situação de referência ou atual no país, mas também um bom monitoramento de indicadores, a fim de identificar o problema e apoiar políticas públicas, empresas e ONGs no gerenciamento de projetos. Indicadores quantitativos e qualitativos são ambos relevantes para avaliar o nível de sucesso e alocação de esforços. Este relatório também sugere ações, indicadores e recomendações para a igualdade de gênero no setor de energia no Brasil.

Chapter 1: Gender Equality in the Energy Sector

In this chapter, we present a brief summary of the main international policies designed to include women in the workforce, especially in leadership roles, and the three major stages of this process, which include: i) acknowledging the problem through evidence based on data, ii) establishing policy, and iii) monitoring this policy through data. In conclusion, we show that in Brazil both government and private companies remain in the first stage.

1.1 Gender Equality at the international level

The correlation between a greater level of diversity in company leadership and a greater likelihood of financial outperforming is investigated by McKinsey & Company's new report "Delivering Through Diversity" (Hunt *et al*., 2018). This study examined corporate cases of inclusion and diversity and found out that companies in the top-quartile for gender diversity on executive teams were 21% more likely to outperform on profitability and 27% more likely to have superior value creation.

Another report prepared by McKinsey Global Institute (Woetzel *et al*., 2015) also shows that women's equality is also economically important. According to this report, US$ 12 trillion could be added to global GDP by 2025 by evolving gender equality. Consequently, the report argues that gender inequality is a critical economic challenge. According to the report, both governmental bodies and companies worldwide could obtain economic benefits by focusing on improving gender equality. Therefore, promoting general equality it is an ethical issue, but also an economic advantage. There are structural issues that need attention in order to empower women. For instance, by developing new legal frameworks to allow women with children to work in flexible hours, and reviewing unfair social norms and attitudes, all aiming at promoting gender equality. The World Economic Forum's Global Gender Gap Report (WEF, 2017) assessed 144 countries on how well they utilize the female workforce and found out that none of them had economic equality between the genders. The WEF has been working with partners in order to help remove the barriers to gender equality worldwide. In Brazil some of the main barriers for gender equality include:

- Women's participation in the job market is smaller than men's participation which reinforces gender stereotypes, leading to less hiring in the sector;
- Women's salaries are still lower than men's (77.5% of the men's average salary), despite holding, on average, more educational qualifications than men, according to IBGE (Agência Brasil, 2018);
- Women's under-representation in decision-making positions, especially in high technology areas, and companies' core business positions;
- Representation in politics: women's participation in politics is still quite low – only 15% in Congress. With the insufficient number of women's representatives in Congress projects and key themes for woman empowerment and gender equality are likely to be neglected;
- Violence against women (femicide) and sexual harassment.

A similar study (Dabrowski, 2017) shows that in the European Energy Sector women only represent between 8% -15% of the total workforce and the majority of women work in administrative and sales roles. Only a small percentage occupies senior and mid-management positions.

Various explanations have been offered for women's underrepresentation in energy field and in high positions in the sector. The most common is that women are less likely to pursue science, technology, engineering and mathematics (STEM) topics. Due to the challenges women face in science and engineering professionals (Moss-Racusin et al.,2012; Reuben et al., 2014; Robinson and McIlwee, 1989; Singh et al., 2013), it is natural that female STEM graduates will be less likely to transitions into occupations in the energy sector. However, this would not explain why the few women which follow the career have difficulties to progress in their jobs. A possible explanation for the absence of promotion of women is in employment and employee expectations. The role of gender ideology in shaping women's and men's notions of desirable or feasible employment given other long-term goals which assume that the maternity is an obstacle for the dedication expected for the professional (Bridges, 1989; Okamato, 1999; England, 1982). This effect affects not only the women's confidence (Cech *et al*., 2011, Sassler *et al*., 2017), but it has a much more destructive effect: employer's discrimination. The expectations of employers result in implicit bias in evaluations that may hinder women from receiving initial job offers or subsequent promotions (Ridgeway, 2011; Moss-Racusin *et al*., 2012; Reuben *et al*., 2014).

In order to change this scenario a number of international strategies, including the promotion of science education for girls and the increase in percentage of women in the hiring and management. They share the idea that a key ingredient is data and the other, long-term policy.

Renewable energy is one of the fastest-growing sectors in the world. Due to its natural multidisciplinary one might expect more women to be involved, however there is still a lack of women's representation in the leadership of this field. Acknowledging this problem, the International Renewable Energy Agency (IRENA), focused on the promotion of renewable energy, has a gender perspective in its annual reviews on the sector's jobs. This type of study could be developed in Brazil in greater depth, potentially supported by the British Embassy via the UK Prosperity Fund, in collaboration with the Brazilian Energy Research Company (EPE) and other institutions.

The IRENA's 2016 Annual Review reported 35% of women in the workforce in a survey of nearly 90 companies. The 2017 Annual Review showed that gender discrimination in renewable energy is less pronounced than in the energy sector as a whole as result of a joint survey with Clean Energy Business Council and Bloomberg New Energy Finance, in the Middle East and North Africa region. In the IRENA's 2019 Annual Review, the edition shows that renewable energy employs about 32% women, compared to 22% in the energy sector overall. In addition, the results indicate that within renewables, women's participation in STEM jobs is far lower than in administrative jobs (IRENA, 2019).

The report also presented some of the main challenges to employment and promotion, such as: a. flexibility in workplace, b. mentorship and training, c. support for parenting, d. fair and transparent processes, and e. equal pay and targets for diversity. It was also highlighted the benefits of cleaner cooking fuels, such as biogas and improved cookstoves, for women (as further described in the international case studies). And on this year report, IRENA emphasised some social entrepreneurial women's initiatives, such as the international network focused on gender and sustainable energy

(ENERGIA), the Barefoot College, Solar Sister, WRISE (Women of Renewable Industries and Sustainable Energy), and the GWNET (Global Women's Network for the Energy Transition).

Moreover, IRENA's report adopts the UN Women statements about women's role as agents of change to scale up the adoption of off-grid renewable energy solutions, and suggests that this has not yet become the mainstream. Results from a survey carried out by IRENA highlighted the importance of access to training and skills-development programmes, as well as improving access to finance and mainstreaming the gender perspective in energy access programmes as fundamental steps to increase women's engagement (Figure 1). This corroborates with further discussions presented in the current report, showing that dedicated training and capacity building programmes for women, can help empower them. This type of initiative should be preferably led by women (e.g. female engineers) in order to encourage and serve as an example to young women who may be interested in working in the energy sector.

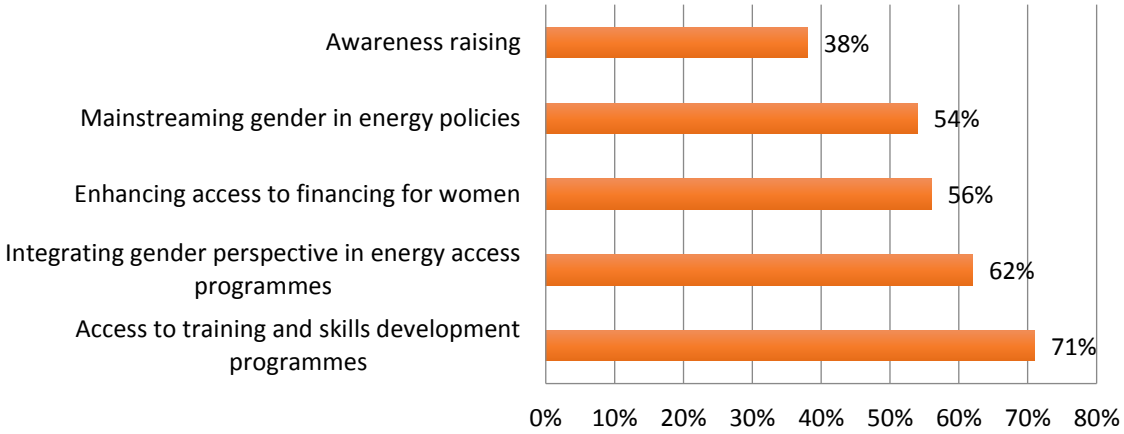

Figure 1: Measures to improve women's engagement in deploying renewables for energy access.

Source: IRENA (2019).

Energy, women and poverty alleviation

An important gender dimension of the energy sector is the impact of energy access on women's lives, especially in terms of poverty alleviation. Social and cultural inequalities and gender-defined roles create a distortion with more negative effects for women when modern energy access is not available (IEA, 2017). Lack of access to good quality energy leads to inadequate use of traditional biomass and polluting fuels for cooking and lightening without a proper gas exhaustion at home, which causes many respiratory diseases after continuum exposure to air pollution. An analysis comparing cooking with clean fuels or improved stoves and cooking with biomass showed that the latest alternative increases the risk of pneumonia by 80% (Dherani *et al*., 2008). In addition, the fuelwood collection is often made by women, with more consequences for their health and welfare (Gunnar K. *et al*., 2011).

In Brazil, the use of LPG for cooking is widespread across the country, but similar situations still remain in some rural areas. Moreover, the implementation of solar-power projects with the participation of women in traditional communities in Brazil, especially aimed at water pumping using solar PV, obtained positive results and acceptance (Fedrizzi, 2003). The use of renewable

sources for energy access has the additional effect of combining poverty alleviation with climate change mitigation.

Batliwala and Reddy (2003) argue in "Energy for Women and Women for Energy (Engendering Energy and Empowering Women)", that the women-energy nexus involves the challenge of gendering energy and the challenge of empowering women through energy. These authors offer a case-study for the village of Pura, located in a rural area in South India, and their results indicate that women work more hours than men. Women also perform the back-breaking tasks and are displaced by agricultural mechanization. Additionally, the authors state that in developing countries, women traditionally eat last and least in a family – women therefore take in less food energy than men. The gender distribution of labour results in negative health impacts. The scarcity of energy services in rural areas has serious social and gender impacts. In Pura, a specific social project on the installation of a community system of biogas plants for energy and water supply has caused impacts such as improving water quality and reducing the time to obtain water by walking long distances and the need of firewood. Access to better water, in turn, reduced the number of diseases. Another effect of the implementation of the system was the improvement of lighting, which allowed to increase the time to perform domestic tasks and to reduce pressure on women during daytime. In order to change this reality, Batliwala and Reddy (2003) suggested that public policies must promote the notion of women as managers and entrepreneurs, and not just beneficiaries, of improved energy services. Similar discussions about gender issues in rural areas and the need for empowering women through the access to production assets were provided by Sandstrom and Strapasson (2017), by assessing the case of Tanzania.

Even though in Brazil the use of wood for cooking is restricted to 3%, it impacts on rural areas, reaching up to 85% of the energy employed for cooking in the rural villages of the Brazil's Northeast (Gioda *et al.*, 2017). The health consequences of using wood as fuel impacts strongly women and children, particularly respiratory problems (SindiGas, 2017).

Therefore, it is fundamental not only to provide energy access to women but also to develop policies that could stimulate them to take management roles in energy companies so that issues on energy & gender may become more present in the corporates' strategies. It is a complex area, which usually needs detailed investigation in order to identify the local needs of those affected by energy policies. Rewald (2017), for example, suggests that "donor community should still advocate for increasing women's access to improved energy, while also calling for more research on the issue." This author recommends further research on the following issues:

(i) The role of traditional energy in women's lives in developing countries;
(ii) The time/drudgery, health/physical, and information/communication burdens placed on women by a lack of energy access;
(iii) Whether and how improved energy access leads to a decrease in time/drudgery, health/physical, and information/communication burdens, further efficiency for income-generating activities, more opportunities in the formal economy, and an increase in education and literacy for women and girls;
(iv) Identification of the best energy sources for decreasing women's energy poverty burdens; and

Whether low-carbon energy sources can be as beneficial for women as some high-carbon energy sources, or even more beneficial.

Several international initiatives and new leaderships have advocated towards women's empowerment in the energy sector. The WoMin initiative[1], for example, is comprised of female leaders in Africa, who defend an Ecofemism capable of bringing a new perspective on extrativism, energy and climate change. This initiative is focused on climate and ecological justice, energy justice, food justice, and gender justice. Similar initiatives have been gaining momentum worldwide, with women concerned with an energy transition which includes a gender perspective. Steinfort (2018) highlights that gender inequality increases the likelihood of a family suffering from energy poverty. She also talks about the importance of undermining energy politics that are reproducing patriarchy as the basis for capitalism, and that there is a need for a new energy model that is built on the needs and labour of the social majority of women.

Another example of international leadership in gender equality is the work done by Vandana Shiva, an Indian environmentalist and physicist, who has been encouraging women's involvement in climate and energy debate worldwide, challenging the current *status quo*. According to Shiva (2012), women are those historically concerned with sustainability, and the social networks are key for promoting women empowerment. In a similar fashion, Sen (2000, p. 235) comments that "nothing is as important today in the political economy of development as adequate recognition of women's political, economic, and social participation and leadership. This is indeed a crucial aspect of development as freedom."

In this report, we discuss several energy projects in Brazil under a gender perspective. These include initiatives in traditional communities where the introduction of photovoltaic technology for water pumping with the participation of women has potentiated positive results and acceptance (Fedrizzi, 2003), as well as several other experiences from the private sector, governments and NGOs.

1.2 Gender Equality in Brazil

For those not familiar with the energy sector in Brazil, there is an overview available in Appendix. Its reading is recommended in order to help understand both the resistance to change and the great potential for the inclusion of women in the energy sector.

1.2.1 Gender equity in the energy sector – an overview

Today women total more than 50% of university students, and almost half of the conferred master's and doctoral degrees. This growth in the presence of women's participation in public life can be attributed to promotion of literacy and increase of day-care structures. This however does not reflect in all fields and in the power structure. For instance, in Brazil, the number of women in politics has been gradually increasing. Since 1997, the Brazilian legislation for the electoral system has established a quota system requiring a minimum of 30% women candidates for election for each political party. The results of the 2018's elections showed a 51% increase in the number of women in the Brazilian Parliament, although only 15% of the politicians in the Parliament are women. It is a signal of gradual change, but the degree of representation is far from ideal. With women comprising 51% of the Brazilian population, 15% representation in politics is a clear evidence of the imbalance of power, let alone the representation at state and municipal levels, which are also in critical and often worse condition than at the national level. In contrast, an

[1] See more about the WoMin iniatiative at: https://womin.org.za/an-african-ecofeminist-perspective.html

interesting case is a collective position for Member of Parliament at the Brazilian State of Pernambuco, in which not only a woman, but a group of women who share the same role. This project is called "*Juntas"*, which means "Together" (Jornal do Commercio, 2019).

Another problem is reaching the leadership. Brazil has a very low share of women in Companies' Board of Directors. **Federal Law Project no. 7179/2017** (under review at the Brazilian Parliament) establishes a quota of 30% for women's participation in the Board of Directors at state-owned companies (Câmara dos Deputados, 2017). This bill was already approved in the Parliamentary Commission of Women Rights, but it remains under discussion at the Congress and without a clear perspective about when it would be voted for. It is worth noting that projects of law in Brazil often take several years to be finally approved by both chambers of the Parliament ("Câmara dos Deputados" and the Senate), whereas some are rejected, and many are archived without further consideration. The way to support projects in the Congress is to establish a constructive interaction with the Members of the Parliament involved. In the case of this specific law project and its potential impacts on the energy sector, it may be worth interacting with the MME's Permanent Committee on Gender, Race and Diversity Issues (Cogemmev) as well.

On the other hand, although the mandatory quota system for public companies is not yet in place, Brazil already has a private-sector initiative called *"+Mulher 360"* (+Woman 360)[2] which helps the business world to become more inclusive. This initiative gives support for three different target audiences: women in companies, women in communities, women in supply chain. It gives support for its partners in terms of promotion (e.g. advisory for CEOs), organisation (including indicators from ETHOS/MM360, best practices, and guidance materials) and dissemination (e.g. events, advocacy, targets) of gender equality initiatives. Regarding the "quota system", it may help encourage and speed up the transition from a patriarchal structure to a more balanced system in terms of gender equity, particularly in decision-making roles. Norway, for example, was the first country to establish quotas (40% in 2003) and is currently with the best gender balance in Board of Directors worldwide. Companies of the energy sector could be motivated by the MME's Cogemmev along with potential international partners, such as the British Embassy, to implement affirmative action policies, for instance, under the support of consulting companies such as *+Mulher 360* .

The absence of women in leadership positions also impacts the energy sector. Brazil has a long experience in the energy sector, supported by a large number of both governmental and private institutions and companies. However, when it comes to gender equality, the energy sector presents an impressive distortion, with only 11% of women participation in decision-making positions in private companies (FGV, 2018)[3]. A preliminary review carried out by the project's team identified 11 companies in the sector (9 under the control of the Federal Government or the State Government and 2 private companies) and the results demonstrate a low participation of women in senior positions in the sector with only 16.4% women in Executive Boards, 13.7% in Boards of Directors, and 20% in Supervisory Boards[4].

[2] Find out more information on this initiative at: https://movimentomulher360.com.br/

[3] Data from the "Guia de Mulheres na Liderança" (FGV, 2018). The report assessed women's participation in decision-making positions in 88 companies (national and multinationals) in 14 economic sectors in Brazil. The best results were shown in the health and pharmaceutics sectors, with 46% e 43% of women in decision-making positions, respectively. From the 30 companies with the best results, only two were from the energy sector – Shell and AES Eletropaulo.

[4] The energy sector in Latin American sector concentrates one of the largest gender disparities: only 20% of all workforces are women. In high management positions, women represent 17%. In boards or in the corporate

The energy sector, differently from the other types of companies, suffers from an addition barrier in the field. In general, women are underrepresented in technological fields and decision-making positions, and receive lower salaries in most jobs in Brazil. This phenomenon is also known as horizontal and vertical exclusion, which is not only anti-democratic but also less efficient (Hunt *et al*., 2015). This is particularly damaging to firms, which are focused in innovation (Dezso & Ross, 2012). An example of a sector in which the combination of vertical and horizontal exclusion is often observed is the energy sector. The percentage female of engineers getting a degree each year is about 30% of the total number of students. However, in the decision-making positions the participation of women is much lower still. The presence of women as professionals in other fields such as medicine or law may lead some people to think that the absence of women in energy is a matter of choice. This is not the case, studies show that at very young age girls are convinced that intelligence, an attribute often related to STEM (Science, Technology, Engineering, and Maths), is a male quality (Bian *et al*., 2017). Consequently, while some forms of discrimination against women appear to be diminishing, gender inequality continues to hold women back of opportunities in the higher positions in companies and public sector. The lack of recognition of this exclusion results in absence of appropriate policies and of monitoring of existing programmes.

The energy sector in Brazil has an additional problem related to gender equity. It has a considerable number of State-owned companies, either fully or partially public - often with the government holding its golden share. Therefore, several companies (e.g. Eletrobras, Petrobras, COPEL, CEMIG, EPE, among others) have the government (either federal or state government) appointing their Board of Directors, Presidents, Executive Directors and other leading positions. There is a public pressure to reduce or even eliminate policy appointments for these high-level roles, particularly when not based on technical criteria, but the situation remains the same in most cases. This Corporate environment is embedded with stereotypes, which often reinforce the historical privileges of men over women. For instance, there is usually an absence of policies of diversity and gender equity in job recruitment processes, especially at medium and large companies in Brazil.

Nevertheless, there are a few initiatives to promote gender equality in the energy sector, particularly linked with transversal government policies. In May 2004 the Brazilian Ministry of Mines and Energy (MME), in partnership with energy public companies, created a Committee to address gender issues in the Energy Sector. The work feeds into the PNPM (National Women's Policy Plan). There is a special concern over communities around the largest energy projects in the country (e.g. large hydropower). Actions are discussed and proposed to minimize impacts of large infrastructure energy projects in smaller communities. The Committee is comprised of representatives from the following Government bodies and public companies: Ministry of Mines and Energy, Companhia de Pesquisa de Recursos Minerais (CPRM), Centro de Pesquisas de Energia Elétrica (CEPEL), Companhia de Geração Térmica de Energia Elétrica (CGTEE), Centrais Elétricas Brasileiras S.A. (ELETROBRAS), ELETROBRAS subsidiaries (CHESF, FURNAS, ELETROSUL, ELETRONORTE and ELETRONUCLEAR), ITAIPU Binacional, Petróleo Brasileiro S.A. (PETROBRAS) and its subsidiaries (Distribuidora BR, TRANSPETRO and Liquigás).

presidency, the percentage drops to 7%. According to the World Bank, following current trends, it would be necessary 79 years to end inequality between men and women in Latin America and the Caribbean. See more at: https://epbr.com.br/mulheres-na-energia-por-enquanto-somos-estatistica/

Established 2003, the PNPM is currently managed by the National Secretary of Policies for Women (SNPM – to be changed from January 2019) at the Brazilian Ministry of Human Rights. It is the main governmental initiative on gender equality in Brazil. The plan is still ongoing and work in 10 different fronts, all related to gender issues. Chapter 5 of this plan, more specifically, sets out an Action Plan to foster and strengthen gender equality of women in decision-making positions nationwide.

Since the PNPM is not in the stage to provide visibility to the issue, gender discrimination data is quite difficult to be clearly presented. Therefore, our project team obtained and organized the number and proportion of women in Executive Boards, Boards of Directors and Supervisory Boards of companies in the Brazilian Energy sector. To date, 17 companies in the sector have been evaluated. Based on a preliminary survey, we observed the low participation of women in senior positions in the sector, with a 11,21% participation in Executive Boards, 11,85% in Boards of Directors, and 18,18% in Supervisory Boards, as shown in Table 1 below which is an original contribution from this report.

Table 1: Women in Executive Boards, Boards of Directors and Supervisory Boards of companies in the energy sector.

Company	Woman CEO	Executive Board			Board of Directors			Supervisory Board			Total women participation
		Number of women	Total	Women participation	Number of women	Total	Women participation	Number of women	Total	Women participation	
Eletrobras	No	2	7	28,57%	1	10	10,00%	1	5	20,00%	18,18%
Petrobras	No	1	7	14,29%	3	11	27,27%	1	5	20,00%	21,74%
FURNAS	No	0	6	0,00%	2	5	40,00%	0	3	0,00%	14,29%
Itaipu	No	2	12	16,67%	1	12	8,33%	0	0	0,00%	12,50%
CHESF	No	0	5	0,00%	0	6	0,00%	0	3	0,00%	0,00%
Eletronuclear	No	1	4	25,00%	1	6	16,67%	1	3	33,33%	23,08%
ENEL (Eletropaulo)	No	2	6	33,33%	1	7	14,29%	0	3	0,00%	18,75%
CPFL	No	1	9	11,11%	0	7	0,00%	2	3	66,67%	15,79%
CEMIG Distribuição	No	2	11	18,18%	1	9	11,11%	1	5	20,00%	16,00%
CTEEP	No	0	5	0,00%	1	8	12,50%	1	5	20,00%	11,11%
Comgás	No	0	6	0,00%	0	8	0,00%	1	4	25,00%	5,56%
Braskem	No	0	9	0,00%	1	11	9,09%	0	5	0,00%	4,00%
COPEL	No	1	5	20,00%	3	7	42,86%	1	5	20,00%	29,41%
Eletronorte	No	0	6	0,00%	1	5	20,00%	0	3	0,00%	7,14%
Light	No	0	9	0,00%	0	11	0,00%	1	3	33,33%	4,35%
Energisa	No	1	5	20,00%	0	7	0,00%	n/a	n/a	n/a	8,33%
PPSA	No	0	4	0,00%	0	5	0,00%	1	3	33,33%	8,33%
TOTAL:		13	116	11,21%	16	135	11,85%	10	55	18,18%	12,75%

Source: Prepared by the authors, based on official information from the respective companies available online.

Gender equality programmes in companies under Federal Government control are aligned with the Gender and Race Pro-Equity Programme, an initiative of the Federal Government with the partnership of UN Women and the International Labour Organization (ILO). In general, companies disclose adherence to the programme, expressing values and principles. On the other hand, Eletrobras, for example, provides a plan with specific actions to promote gender equality in the company, which deals with people management, organisational culture and the implementation of innovative actions. Therefore, this is an area in which the British Embassy could give some support (e.g. via the UK Prosperity Fund's Energy Programme), working with companies to ensure that they have a proper strategy.

In addition to these programs, we highlight the project called "*Sim, elas existem*" (Yes, they exist) (Warth, 2018; Maciel, 2018), which was recently led by two civil servants (Agnes Costa and Renata Isfer) at the Brazilian Ministry of Mines and Energy (MME). The objective of this project was to identify female candidates potentially interested in leading energy roles in the Brazilian Government, including at the MME and its affiliated companies and regulatory agencies. The project's coordinators then released a list of candidates to the new government. A similar initiative called "Lights on Women"[5] is led by the Florence School of Regulation (FSR) at international level, since 2017. This initiative acts as a platform to value women's expertise, publications, projects, and professional achievements, making their contributions visible to the energy community. There are also eligible projects for specific scholarships for women interested in STEM fields[6].

All the initiatives, though important, lack indicators and in some cases are based on leadership initiatives that might end when the person in charge is replaced. For instance, in September 2018, during the opening ceremony of Rio Oil&Gas, Petrobras Director for Exploration and Production, Solange Guedes, announced the company´s plans to increase at 40% women participation in decision-making positions. According to Solange, the company's target is to increase from the current 18% to 25% by 2025, in a meritocratic approach. The company expects to: a) invest in training programmes for women leadership; b) stimulate more women to work on operational activities; c) increase information to girls on middle-year schools to promote areas such as science, technology, engineering and maths in order to stimulate their interest in energy, among other areas; and d) increase the number of scholarships to young women at the university level. The initiative is very positive, but to follow it up is equality important to ensure its success over time.

1.2.2. Gender Equality and Economic Growth in Brazil

The link between economic efficiency and diversity which is ubiquitous in the international literature is a current topic of discussion in Brazil. The international studies show that diversity in fact produces innovation, not only prompting individuals to have new ideas (Philips, 2014), but also developing collective intelligence (Wooley *et al.*, 2015). To be efficient, targets must be well-planned and follow a robust operational programme, including an increase of informative campaigns, awareness and capacity building.

Due to this lack of Brazilian literature on the topic, the community working in the energy sector does not recognize the economic value of the diversity. Even when a government policy is

[5] For more information on the FSR Lights on Women initiative, access: https://medium.com/lights-on-women

[6] See more at: https://www.techwomen.org/participants/eligibility-and-application

established, it is not properly implemented in the sector. One example of this was observe in our study where a few people demonstrated that there are some resistances for the use of quotas for gender equality in Brazil, although they have been proven useful to speed up the process of social inclusion in many areas. Quotas are often seen as something not meritocratic and many groups prefer the use of targets instead. This controversial debate could be more properly addressed in the energy sector through workshops involving experts working on gender equality issues, sharing experiences and advices for improving local practices at company level. The British Embassy, for example, could promote and support initiatives alike.

The relation between gender equality and economic growth in Brazil was studied by Agénor and Canuto (2013), with a long-run impacts analysis of policies aimed at fostering gender equality. They applied a computable overlapping generations (OLG) model to consider the impact of access to infrastructure on women's time allocation, human capital accumulation, inter- and intra-generational health externalities, and bargaining between spouses. The study involved two experiments, one related to improved access to infrastructure, on a policy aimed at promoting access to core infrastructure, and another one related to reduction in gender bias in the marketplace, with an "equal work, equal pay" policy aimed. The results for the first case show that externalities created by improved infrastructure have a significant impact on women's time allocation and bargaining power over family resources, since a public policy aimed at promoting access to infrastructure brings growth by the natural increase in the public-private capital ratio and also promotes the possibility for mothers to spend more time to market work instead of home production. These direct and indirect effects considered in the model suggest an additional percentage points (between 0.5 and 0.9) to Brazil's annual rate of output growth. For the case of reduction in gender bias in the marketplace, the results suggest that an "equal work, equal pay" policy could add up to 0.2 percentage points to the country's annual growth rate. Thus, the authors conclude that policies fostering gender equality may have a substantial positive impact on long-run growth in Brazil.

Companies and public entities should take further action to increase diversity and reduce gender gap (Costa *et al*., 2018). The underrepresentation of women in leading job positions generates less critical debate, less innovation and reduce quality of decision-making (FGV, 2018). It is key to have a gender policy not only in job recruitment but also in the promotion process, i.e. an inclusion view on both hiring and progression throughout the institutional structure. Therefore, women participation in decision-making process is fundamental to transform Brazil into a nation in which equal rights are not only a constitutional statement, but also a reality.

Although the energy sector in Brazil seems not to understand the positive economic impact of gender equity (and diversity more broadly), it perceives the democratic aspect of it. In this sense, it converges with the international movement. The major equality initiative of the sector, the PNPM, aligns with the United Nations Sustainable Development Goals (SDGs)[7], which has brought to attention the need to create a more balanced society in terms of women's rights and power. In particular, it contributes to meet the UN's SDG 5 – "Achieve gender equality and empower all women and girl is successful". Besides, the UN Women[8], in partnership with companies based in

[7] For further information on the UN Sustainable Development Goals (SDGs), access: https://www.un.org/sustainabledevelopment/sustainable-development-goals/

[8] See more at: http://www.unwomen.org/en

Brazil (e.g. Coca-Cola and Itaipu Binacional[9]), promotes actions to empower women. Further information on the UN SDGs in the context of this project is available in the Appendix.

1.2.3 Assessment of key statistics and indicators on gender equality

Initiatives as PNPM are certainly important and contribute to the increase of diversity, but only acknowledging the problem and implementing initiatives is not enough. Accompanying the affirmative action programmes with statistics and indicators is necessary. In this context, this section provides a review on the share of women in different positions in the energy sector, including in decision-making roles, from private to public institutions.

Gender equality programs in companies under Federal Government control are aligned with the Gender and Race Pro-Equity Program, an initiative of the Federal Government with the partnership of UN Women and the International Labor Organization (ILO). In general, companies disclose adherence to the program, expressing values and principles. Only Eletrobras provides a plan with specific actions to promote gender equality in the company, which deals with people management, organizational culture and the implementation of innovative actions.

In Brazil, the number of indicators to assess gender equality and its progress over the years has shown increase. The Brazilian Statistics and Geography Institute's (IBGE) demographic census and PNAD (*Pesquisa Nacional por Amostra de Domicílios*) are important references in this regard, particularly because all their information can be disaggregated by sex, for instance, gender norms at household level, which is useful to assess when women are the main (or the only) provider. These references also have available information to feed into gender research, regarding job market, access to education, fertility, health, among other issues. Another important instrument to find gender disaggregated data in the public sector and companies is the Brazilian law of access to information (Federal Law no. 12.527/2011). Even when the government does not provide consolidated the data, it is possible for researchers, journalists and any other citizen to obtain raw data and write about the subject, creating pressure on the development and implementation of public policies.

In addition, in 2010, it was approved at Brazilian Congress a bill (Law nº 12.227, 12 April 2010) establishing the "*Relatório Anual Socioeconômico da Mulher – RASEAM*" (Women Socio-economic Annual Report). RASEAM includes indicators that should be annually assessed in order to inform policies. The indicators include, for example, employment, wages, violence (physical, sexual and psychological), life expectancy, mortality rate, education, health and access to energy. The database is generated from the IBGE and its mains census - Pesquisa Nacional por Amostra de Domicílios (PNAD); Pesquisa Mensal de Emprego (PME); the Institute for Applied Economic Research (IPEA); President's Cabinet; and the Ministries of Work and Employment, Foreign Affairs, Justice, Health, Education and Social Security. Therefore, RASEAM is an important tool to support public policies on gender equality; however, only 11 states out of 26 states of Brazil, are covered by the report. In 2012, a working group was officially established (*Portaria no. 119/2012*) to monitor the indicators from the "*Observatório Brasil da Igualdade de Gênero*" aiming at contributing to the definition of

[9] More information about the ITAIPU's initiatives on gender equality is available on the following websites:
https://www.itaipu.gov.br/responsabilidade/incentivo-equidade-de-genero
http://sosmulherefamilia.blogspot.com/2014/05/empresas-brasileiras-firmam-acordo-para.html

indicators to support the RASEAM. The working group should also suggest improvement of existing and new indicators, when necessary, as well as new policies to be included in the National Plan.

In 28th February 2019, the Brazilian Superior Court of Justice (STJ) and the UN Women signed a Memorandum of Understanding aiming to achieve the gender equality SDG. The agreement focuses on the promotion of actions to reduce inequalities, including the STJ adhesion to the HeForShe movement, incentives to engage men in gender equality initiatives, and studies to identify factors that contribute to the participation of women in positions of power and decision-making. The Court has also established "Equilibra", a women's institutional participation programme in the organism (STJ, 2019).

Table 2 shows indicators on Gender Equality from PNAD. This project will further assess these references and the need for additional indicators, as well as how much the data collected accurately represent the full picture.

Table 2: Indicators on Gender Equality from PNAD 2016.

Indicators	What was calculated	Brazil	Men	Woman	Unit
Average hours in domestic work by sex	Weekly average hours dedicated to people care and/or domestic work (people 14 year or older)	16,7	11,1	20,9	Weekly hours
	Weekly average hours dedicated to people care and/or domestic work as a second (or additional) job (people 14 years or older)	14,1	10,5	18,1	Weekly hours
Average hours combined with paid work and domestic work by sex (total working hours)	Average hours combined with paid work and domestic work by sex (total working hours) (people 14 years or older)	52,9	51,5	54,4	Weekly hours
Participation in the work force for people aged 15-24 and 15 and older, by sex	Participation in the work force for people age 15 and older, by sex	62,9	74,0	52,8	%
	Participation in the work force for people aged 15-24, by sex	54,5	60,7	48,0	%
Proportion of self-employed people, by sex	Proportion of people age 14 and older who are self-employed, by sex	24,7	29,0	19,0	%
Proportion of people working to help someone at home, by sex	Proportion of people age 14 and older working to help someone at home, by sex	2,4	1,5	3,6	%
Proportion of employers, by sex	Proportion of people age 14 and older, who are employers, by sex	4,7	5,7	3,3	%
Percentage of workers, by sex, according to the economic activity sector (Agribusiness, Industry and Services)	Percentage of workers age 14 and older, by sex, in the Agribusiness sector	10,0	14,0	4,7	%
	Percentage of workers age 14 and older, by sex, in the Industry sector	20,8	28,4	10,7	%
	Percentage of workers age 14 and older, by sex, in the Service sector	69,2	57,6	84,5	%
unemployment rate aged 15-24, by sex	unemployment rate aged 15-24, by sex	27,2	24,1	31,3	%
wage difference *	income ration people age 14 or older (average in 2016) (in 2018 – 77,5)	76,5 **	-	-	Income ratio W/M
Proportion of workers in part-time jobs by sex	Proportion of people age 14 and older working in part-time jobs by sex	20,2	14,1	28,2	%
Workers aged 25-49 with children (age 3 and younger) and without children, by sex	Workers aged 25-49 with children (age 3 and younger), by sex	70,8	88,7	54,4	%
	Workers aged 25-49 without children, by sex	74,4	83,6	65,8	%
enrolment in elementary school, by sex	enrolment in elementary school, by sex	95,0	94,8	95,2	%
School attendance at final years of elementary school and high school, by sex	School attendance aged 11-14, by sex	98,9	98,8	99,0	%
	School attendance aged 15-17, by sex	87,2	87,4	87,1	%
Completion rate at elementary school, by sex	Completion rate at initial years of elementary school aged 13-15, by sex	93,4	91,8	95,0	%
	Completion rate of elementary school aged 17-19, by sex	83,9	79,7	88,3	%
Level of education from the population aged 25 or more, by sex	Level of education from the population aged 25 or more, by sex – without instruction or elementary school incomplete	41,8	43,4	40,5	%
	Level of education from the population aged 25 or more, by sex – Elementary school completed and High school incomplete	13,1	13,5	12,7	%
	Level of education from the population aged 25 or more, by sex – High school completed and University degree incomplete	29,7	29,6	29,9	%
	Level of education from the population aged 25 or more, by sex – University degree completed	15,3	13,5	16,9	%
Participation of women n Ministerial decision-making positions	Participation of women n Ministerial decision-making positions	-	-	7,1	%
Participation of Women in Management Positions	Participation of Women in Management Positions	-	-	39,1	%
Proportion of women as policy officers	Proportion of women as policy officers	-	-	13,4	%

* Women's wage represents 76,5% of men's wage

** Updated data, from 2018, increase this percentage to 77,5%.

Source: Prepared by the authors, based on information from (IBGE – Brazili7an Institute for Statistics)

Moreover, building on IBGE's Demographic Census, the Secretariat for Women Policies, in partnership with the UN Women and the UK Department for International Development, created the "*Sistema Nacional de Indicadores de Gênero*" – SNIG (National System for Gender Indicators). The system allows the access to a set of key gender indicators. Along this project, we will also assess these indicators and how they have been monitored and translated into policy.

In addition, we highlight the online Women Empowerment Principles' (WEP) Gap Analysis Tool[10], with 18 multiple choice questions that help the company evaluate its performance in terms of gender equality. This tool is free of any charge and can be used by companies that want to evaluate their gender equality policies and programmes. More than 800 companies in 90 countries already use the system. Another important initiative is a Women's Fund[11] led by Goldman Sachs ("Launch With GS"), which finances women entrepreneurs or companies that want to value women, as well as certificates for companies that prioritize diversity in their work environment.

1.2.4 Gender assessment on education and science

In addition to the increase in the presence of women in leadership positions in the energy sector, the percentage of women interested in hard sciences has to increase. This can be done with implementation of strategies to eliminate stereotypes and understand why women often do not select some science and engineering courses at the university level given they are the best students of math at the basic studies. Apparently, many women do not feel encouraged to take these courses due to hard perspectives in the job market afterwards, currently dominated by men, among other issues.

There are several gender equality issues looking at educational background. For instance, some energy-related disciplines in Brazil are still male dominant. This section will provide some relevant figures about that and identify its main causes.

The origin of the discrepancy gender equality in the Energy sector also includes academic training for meeting its job demands. Statistics from the "Superior Education Census" in Brazil (INEP, 2017) demonstrate a smaller percentage of women in courses whose students are more likely to make a career in the Energy sector. The census shows that most of the students of subjects like engineering, math, physics and finance, closely related to the energy sector, are men (around 75% or more). This tends to perpetuate or change in a very slow pace, if no policies and/or incentives are in place for a real change in the coming years and decades. Historically, we still find discrepancies in salaries and restrict access to decision-making roles for women. In the case of the engineering, however, the percentage of women increases if the master programmes are included, which suggests that women opt to obtain more educational background for working in this business sector. This might be due to a response to stereotypes present in the universities for historically male-dominant courses.

There is new draft bill (PLS 398/2018) at the Brazilian Senate, which aims at encouraging the participation of women in the STEM (Science, Technology, Engendering and Math) areas. The Bill

[10] The WEP Gap Analysis Tool is available at: https://weps-gapanalysis.org/. See further information at: http://movimentomulher360.com.br/2018/11/ferramenta-gratuita-permite-avaliar-disparidades-entre-homens-e-mulheres-nas-empresas/

[11] More information on the Women's Fund is available at: https://weps-gapanalysis.org/

proposes the inclusion of a guideline in the National Curricular Common Base aiming at looking for strategies to mitigate cultural prejudices and barriers to the participation of women in these areas, and also proposes to include in the Law innovation and scientific and technological research in the work environment as a new method of stimulating women's participation in the STEM areas. PLS 398/2018 was presented in October 2018, and it is now the responsibility of Senator Telmário Mota to issue a report. However, these advances might suffer adverse effects from the new federal government's posture that considers teaching equity as gender ideology.

The situation is even more critical when looking at gender equality combined with racial issues. For instance, the number of black women who reach academic careers as professors in Brazil is very small, representing less than 3% of all docents (teaching staff) in post-graduate programmes, according to the 2016 Higher Education Census (Ferreira, 2018).

Chapter 2: Case Studies

This chapter provides examples of energy & gender initiatives in governments, companies, and independent organisations in Brazil. In addition, a brief review on international cases of possible interest to Brazil is presented.

2.1 Governmental Initiatives

2.1.1 'Light for All' programme (*Programa Luz para Todos* - LPT)

In 2000 the IBGE *census* found out that 10 million people (2 million families) in the rural area of Brazil had no access to electricity (around 28.5% of the rural population) (Ribeiro, 2015). This led to the creation of the "Light for All" Programme, in 2003 (Law 10.762/2003). This programme was the most important rural electricity programme in the country's history.

The main characteristics of the programme includes:

- it is free of charge for the consumer and partially subsidized to the utilities;
- Decentralized structure, involving key stakeholders from the public sector, civil society and private sector, each one with specific and delimited roles;
- Integrated approach with developing programs to add income, which considers energy as a development tool.

The "Light for All" programme was a very successful initiative in bringing electrification to rural areas across the country. The programme was targeted to end by 2018. However, due its importance, it was extended until 2022. The programme includes several public and private institutions such as: i. Ministry of Mines and Energy and its National Commission for energy universalization; ii. National Management Committee; iii. State Level Management Committee; iv. Eletrobras; v. Executing Agencies – utilities; vi. Community agents.

In November 2018, when the LPT program completed 15 years of existence, Ministry of Mines and Energy announced updated numbers with additional 53 thousand connections, benefiting around 212 thousand people. As a result, 16 million people in total, received electricity access through the programme (MME, 2018).

Gender impact from the LPT programme:

A survey was undertaken by the Ministry of Mines and Energy, after 10 years on the programme. The main results demonstrated a considerable impact on women, from the LPT programme. The results show women were able to start economic activities within their communities (MME, 2013). Around 7.5% of the people interviewed confirmed they started an economic activity with access to energy, through the programme. As per Figure 2 below, the main activity was craft, followed by sewing and retail, most activities as entrepreneur. This percentage may seem low, but in total numbers, it means around 245 thousand women started a productive activity after access to electricity (Ribeiro, 2015).

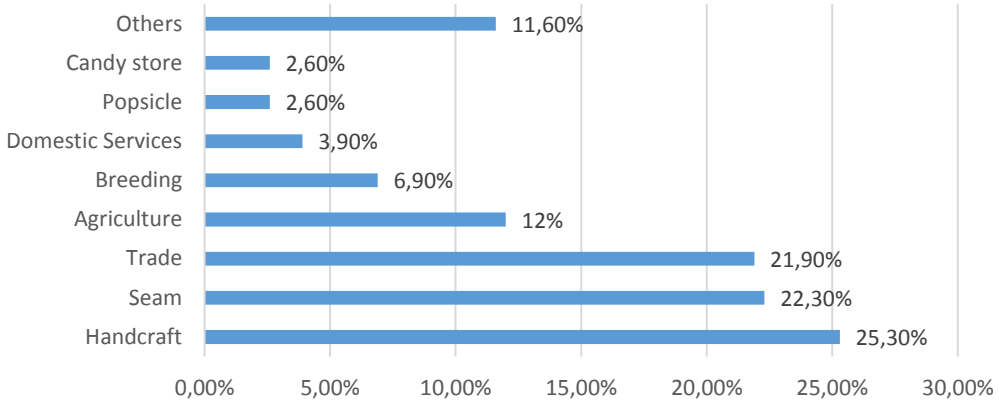

Figure 2: Economic activities initiated by women after the LPT programme

Source: MME (2016).

On the educational side, 9% of the women who benefited from the programme began or resumed studies as a direct result of the LPT (Figure 3). It meant 309.178 women back to school as a result of the Light for All program.

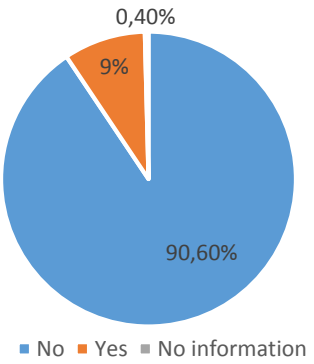

Figure 3: Residences where any women started or went back to studies

Source: MME (2016).

With regard to public security, 81.8% (around 2,5 million of the families interviewed) felt LPT brought more security for women within the community. 79.2% of the women interview stated, after the LPT programme, they felt safer to stay at home alone (MME, 2013) (Figure 4 and Figure 5).

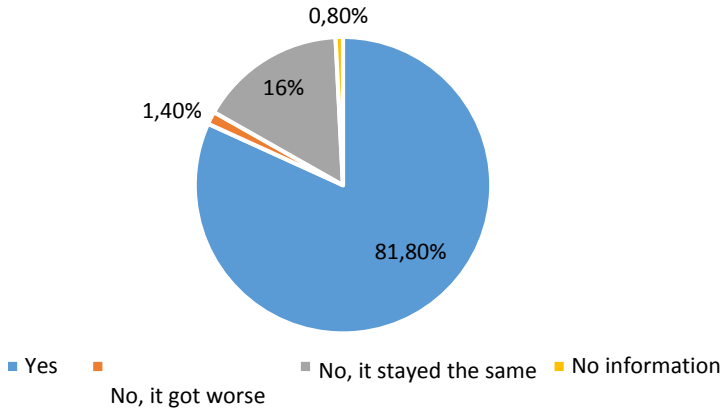

Figure 4: Percentage of perception of more security for women after the LPT programme.

Source: MME (2016).

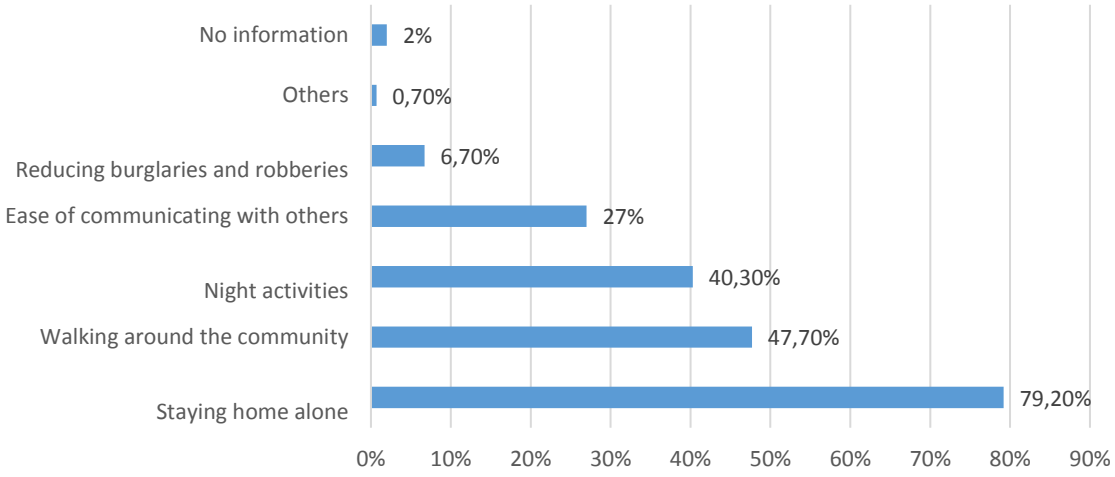

Figure 5: Activities in which women feel safer

Source: MME (2016)

Regarding life improvement using home appliances, 57.4% of women reported starting to spend more time in other activities once they were able to use home appliances (fridge, *tanquinho*[12] and washing machine). These "other activities" include: helping husbands in their business, spending more time with children and other paid jobs (MME, 2013) (Figure 6, Figure 7, Figure 8).

[12] *Tanquinho* is a washing machine without centrifugation system, usually cheaper and smaller than a conventional washing machine.

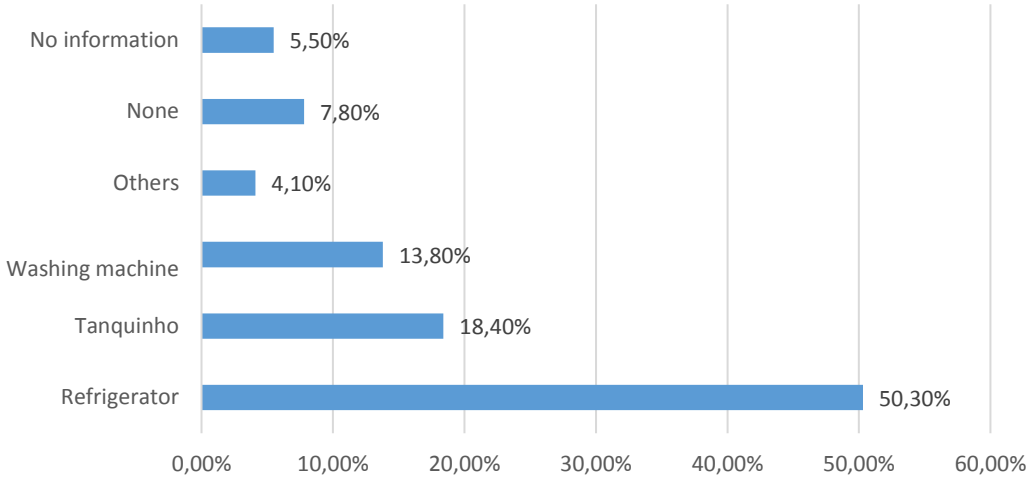

Figure 6: Purchase of home appliances

Source: MME (2016)

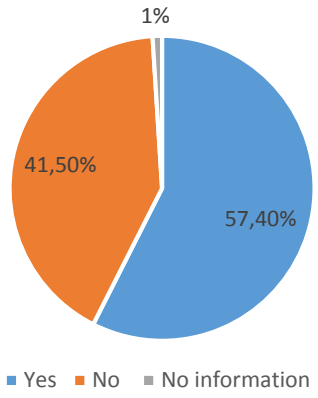

Figure 7: Percentage of people who believe spent more time in other activities after home appliances.
Source: MME (2016).

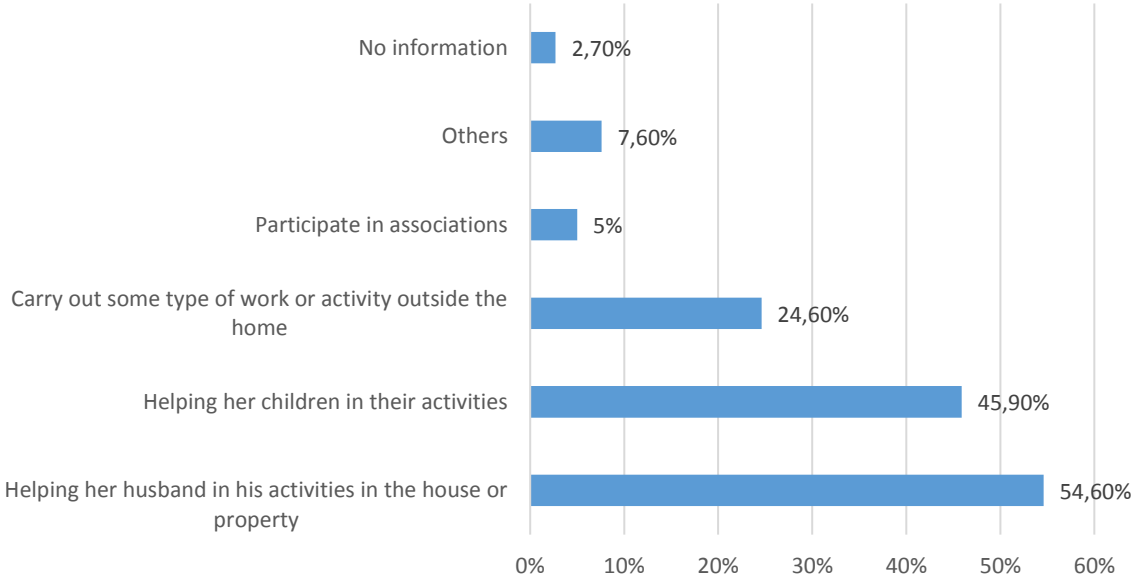

Figure 8: Other activities women start to engage in after home appliances

Source: MME (2016).

2.1.2 National Housing Programme (*Minha Casa Minha Vida* - MCMV)

"Minha Casa Minha Vida" (My House, My Life) is a programme launched by the Brazilian Government in 2009, aimed at subsidising the acquisition of a first residential property by low-income families. This programme involved the installation of PV systems on the rooftops of the houses, and other types of energy access (e.g. street lightening). It has encompassed 92% of Brazilian municipalities, with investments approximately R$ 319 billion (about £ 67 billion) and 4.4 million of residential units.

Instituto Escolhas and Fundação Getúlio Vargas (2019) launched a report on MCMV, which assessed some of the critical points of this programme. These include the distance between residential units and working places or urban centres. Several habitational areas were located in urban peripheries with poor access to public services and collective infrastructure. However, in general, the programme provided several benefits, by giving dignity to many families across the country.

It is important to point out that the MCMV programme was carried out along with another benchmark programme called *Bolsa Família*, which provides monthly funding support for low income families nationwide. *Bolsa Família* is a reference case on women's empowerment (Silva & Silva, 2016). Among its multiple benefits, the programme pays the entire funding support directly to the woman responsible for the family (rather than to the man). This allows them to have a better control of the expenses and avoids them depending on men for covering their daily expenses.

MCMV case in Juazeiro, State of Bahia, Brazil:

In 2012, the company Brasil Solair signed a cooperation agreement with the Socio-Environmental Fund from Caixa Econômica Federal (a national bank) in order to implement a Pilot Project for the use of solar panels in two condominiums[13] from the "Minha Casa Minha vida" Programme, in Juazeiro (State of Bahia) - Praia do Rodeadouro and Morada do Salitre. These two areas were selected due to two complementary factors: high levels of solar exposure, and low-income population. This was only possible because in the same year a Normative Resolution (no. 482/2012) from the National Power Regulatory Agency (ANEEL) regulated the marked for distributed generation. Consumers were then able to generate their own electricity, from renewable sources, and sell its surplus to the grid. By "selling" the electricity it means that the consumer receives credits (in electricity, i.e. not payment in cash) that can be used in the next bills.

For the pilot project in Juazeiro, ANEEL published a new Resolution (Normative Resolution no. 4.385/2013) to regulate the implementation of this pilot. A business model was authorised for the social housing to sell the total energy generated, either to the utility or in the free market. The decision to sell the total of electricity generated was more appropriate, as the community has the electricity bill subsidised under the program of social tariff, in which lower income consumers pay less for the electricity generated. The ANEEL resolution was valid for 36 months.

This was an important difference when compared to a regular situation of Distributed Generation, where surplus energy sent to the grid receives credit in electricity. In this case, the credits would not be used by the consumers due to its already low use of energy. The possibility of selling the

[13] Condominium (*condomínio*) in Brazil usually refers to a group of houses or buildings in a same communal area or to the apartments in a same building.

generated energy, instead of only getting credits for future use, was also a test to assess if this method would be more efficient (Cunha, 2017). In terms of investments, the Socio-Environmental Fund from Caixa Econômica Federal (bank) invested R$ 6 million in this project (non-refundable) and Brasil Solair, a company responsible for the PV panel installation, invested R$ 880 thousand. The main objective was to make the project a source of income and jobs in the condominium where the PV panels were installed.

This project was the first micro solar-power plant in Brazil and still the largest case in the residential sector, with 9.156 PV panels installed on rooftops. The project became operational in 2014 (Figure 9). As the project was created to operate for 36 months, the commercialisation of energy ended in October 2016.

Figure 9: Houses from the MCMV Juazeiro condominium.

Source: MCMV Programme.

The total income generated by the project was R$ 3.134.065,80, equivalent to R$ 97.939,55 by month. 60% of this total goes to the families, 30% are applied to an investment fund for the condominium (managed by an association), and the remaining 10% goes to the maintenance of the houses. These funds supported improvements such as a community centre, computers room, bus stop, traffic sign and weekly medical care (Governo do Brasil, 2015). Each family received R$ 1.880,44, equivalent to a monthly average of R$ 58,76.

To make sure the income generated with the PV solar was properly and well-invested, the families organised two associations (one for each group of residences). A woman called Marinalva Rodrigues, who used to wash clothes for a living to raise her 5 children, became the manager of the Consulting Board from one of the Condominium (Praia do Rodeadouro).

The project also included a capacity building aspect. The Brasil Solair instructed the leadership in the community about how to manage the resources. The division of the income obtained from the sale of the additional electricity generated was established in an assembly and incorporated into the condominium's internal regulations. Since both condominiums were constructed within MCMV,

a programme which preferentially finances families with a woman head of household, part of this training was given to women.

The operational model of PV panels integrated to the grid is relatively simple, as shown in Figure 10.

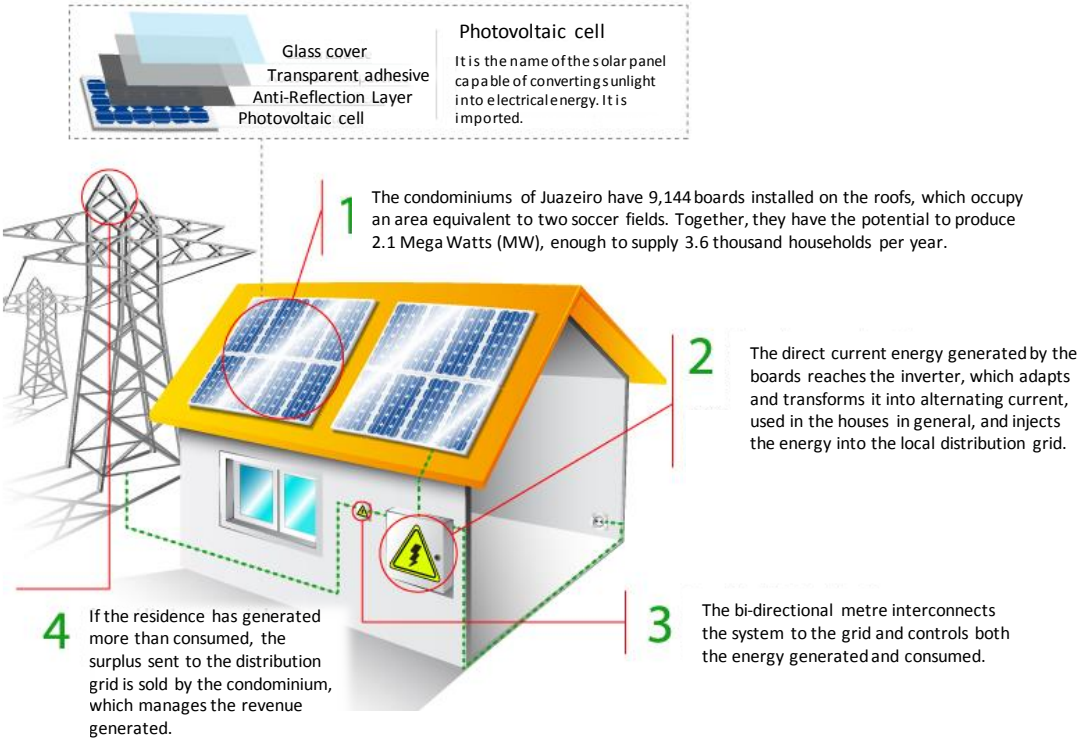

Figure 10: How the PV system works at MCMV programme in Juazeiro – BA, Brazil.

Source: Brazilian Government, Programa Minha Casa Minha Vida. Figure translated by the authors.

What seemed to be a great initiative, with income generation for lower income communities and women empowerment, resulted in a failure. Because their contract with the Brasil Solair ended, the families were unable to commercialise the energy. The current situation is energy being generated and not used. Thus, the total energy generated by the panels is lost as the utility cut the connection in January 2017.

Another problem of the project is that the capacity building only reached 10% of the occupants and it did not include training to learn how to manage the project after Solair Brazil agreement would be finalised. The community has no idea about the technologies involved. Therefore, the project was simply discontinued without further information to the community (Melo *et al.*, 2018). As a result, the population is quite frustrated. There is a general feeling of dissatisfaction. The integrity of the existing equipment is under threat, given that almost 40% of the workers from the community are unemployed, some are considering selling the panels.

In order to use and "sell" the energy generated through the regular distributed generation policies, the condominium would need to invest a substantial funding to adapt its equipment. The costs to adapt the system were estimated around R$ 3 million (for specific adaptations in the system) plus R$ 410 thousand from the utility for the meters.

Brasil Solair provided an economic sustainability analysis for the project. Considering the solar panels lifetime of 25 years and the amount of electricity sold at R$ 340.00/MWh (2015 price

average), the project presented a payback between 8 and 9 years. This indicated the viability of the project. However, political will is necessary to take further this and other similar initiatives. This includes investments in equipment, training (from the government) and the necessary regulatory framework to make it happen correctly.

Information from personal contacts on MCMV project implemented in Juazeiro/BA

The project qualified women from the community to work on the installation of the panels and, then, to carry out maintenance of the equipment. Apparently, eight women were trained and participated in the execution of the project and two were responsible for maintenance. The company involved had its own engineers (possibly all men), but little was said about it. Almost all houses have women as their legal borrower ("*mutuária*") and many as head of household. The MCMV project gave priority to women and people with disabilities to lead the process. It is clear in the daily life of the two residentials (condominiums) that women were deeply involved in the project, especially operational in maintenance activities, including cleaning the PV panels. Women also acted as trustees of the buildings and in the political life of the community. The trustees are responsible for the financial investments in the community from the revenues obtained from the sale of electricity to the grid. The project contributed to women empowerment by giving them an opportunity to work on solar energy, even beyond the project.

Secondary data collected by a researcher (contacted by the authors) through questionnaires with residents, suggest that monthly family income of 48% of the families consulted is up to 1 minimum salary in Brazil (R$ 954,00 a month, at the time of research). 40% of families reported receiving only *Bolsa Família* or other government aid. In turn, 8% have monthly family income between 1 and 2 minimum salaries, 3% do not earn any income, only 1% earn between 2 and 3 minimum wages. Therefore, at least 40% of those surveyed, the average income obtained with the project represented an increase of 25% in the monthly income of the family.

According to one of the contacts, it would be advisable for more women to be technically qualified for installing PV systems in order to maintain progress in this type of business, given that most of the residents have little formal education. By empowering women in the engineering sector, more women could be motivated to follow this professional pathway. The Federal University of Vale do São Francisco (UNIVASF) could potentially help in this regard, as well as the National Service for Industrial Training (SENAI).

In contrast, some women in the community have complained that they were not properly involved in the project and that most of the residents are not aware of the technology, why it is important, and how it works. Some residents, for example, have shown concerns that the PV panels on the rooftops of their houses may not be good for their health. This situation reveals that several gaps occurred in the project's implementation, including lack of educational campaigns.

MCMV case in different municipalities of the State of Goiás, Brazil

Another Project under assessment is the Solar Power Project (Projeto Casa Solar), in the State of Goiás. The government of Goiás installed PV panel in 1.2 thousand houses under the MCMV. Four municipalities were already benefited from the solar programme: Pirenópolis (149 units), Alto Paraíso (40 units), Palmeiras (740 units) and Caçu (260 units). It is expected an economy of 70% in the energy bill from these houses.

2.2 Initiatives from Energy Companies

2.2.1 Light S.A.'s project for the use of solar panels in Rio's favela

Light is a private energy company in the State of Rio de Janeiro, specialising in electricity generation and distribution, including the city of Rio de Janeiro and its surrounding areas. CEMIG, a state-controlled company from the State of Minas Gerais, is its main shareholder.

About 25% of Rio´s inhabitants live in "favelas" (slums), in areas without an urban plan nor proper infrastructure, or access to public services such as electricity distribution. With the emergence of new technologies and electronic devices, along with income increase in some communities, energy consumption is up in most favelas. However, there is a "culture of non-payment" where dwellers get their energy directly from overhead cables, creating a system where their homes use electricity without paying for it (Cascardo, 2018). However, this irregular electricity distribution also presents challenges for the communities: residents without an energy bill have no proof of residency; and they are vulnerable to electrocution and fire due to overloads in the transformer and cables. For the electricity distribution company, this situation is also a challenge to resolve.

In order to change this reality, Light created a project called "community energy", in which local residents have full participation in the process of managing and generating their own power through renewable energy, particularly solar energy. The idea was to offer electricity at an affordable price and quality service, as well as to reduce dependence on irregular connections to the grid.

The first project was carried out in the Santa Marta community, by the social organisation "Insolar"[14] (*start-up*) during a period of two years. The focus was on the installation of photovoltaic systems (150 PV panels). The project works in collaboration with a variety of stakeholders, providing information about the technology used and environmental education. The main idea of "community energy" is that local members have full participation in the process of managing and generating their own power through renewable energy (REN21, 2017). Considering that this is already in line with the *modus operandi* in Rio´s informal settlements, the implementation of this concept would come as a natural solution to help dwellers to pay a reasonable price for electricity, end dependency on major energy companies, and to receive quality service. The approach to this investment may be different in each community, according to size, structure, political involvement, background and the need of each area.

In addition, Light is also concerned about the growth of fraud. In 2018, for example, clandestine connections grew by 4%. The company has invested in community outreach programmes and regularisation in pacified favelas. However, several issues remain unresolved, such as:

- In an area controlled by militias or drug dealers, sometimes a company does not have ways to safely operate and to deliver energy bills. Light only acts in places where the State is present;
- In irregular areas, Light does not know how many clients they have. In these areas, it is common to have electricity dim and burning of electrical appliances, whereas in regular

[14] See more at: https://insolar.eco.br/nossa-historia/

places, the company knows the number of clients and can distribute the appropriate amount (Amado, 2013).

Light is still assessing its pilot programme for the use of PV systems in Rio's favelas. Another concern is that some panels may be easily stolen and traded illegally. In the case of this initiative, the panels were offered for free, i.e. with no expenses for the consumers. The project was supported by the Consulate of Germany, among other partners. This type of initiative could be scaled up and reduce the expenses for a legal energy inclusion in the favelas. On the other hand, it is dependent on social policies or special programmes from the private sector (such as this from Light and partners) to be viable so far. It is also worth noting that not all the consumers in the favelas are illegally connected to the grid, some are formally connected and subject to paying energy bills regularly, although illegal connection is still the norm in the communities. Further information is also available online[15].

2.2.2 Shell's gender programme and other clean energy initiatives

Shell is one of energy companies that has adopted gender equality policies. The company states that it is committed to helping women find careers in the engineering and technology sectors. Following the World Economic Forum commitments, Shell has signed an agenda to improve gender equality (WEC, 2016).

In this way, Shell has development the following measures: (i) STEM global program, in which more than 40% of Shell's trainee admissions in STEM areas are now women; (ii) creation of Women's Career Development Programme and Senior Women Connect, both are supported by mentoring cycles and also by learning events; (iii) support flexible working arrangements, such as Equal Lives Programme[16]; (iv) adopt a global minimum standard of 16 weeks paid maternity leave; (v) equal wages gender policies; (vi) encourage younger women engineers (Williams, 2018). In addition, Shell has a large diversity programme that includes, besides gender, disability. By publishing its reports and balances, Shell has brought ahead its campaign through data in order to closing gender gap in engineering and technology.[17]

Social Projects by Shell (not only related to gender issues):

a) "*Quipea*" is a project that involves "*Quilombos*" (small villages originated from escaped slaves during the Brazilian slavery regime) in the Shell's Environmental Education Project. This is a condition for obtaining federal environmental licensing, conducted by Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA). The initiative includes eight municipalities in the area of influence of two oil platforms: one in the fields of "Parque das Conchas" on the coast of Espírito Santo; and another in the fields of "Bijupirá and Salema" on the coast of Rio de Janeiro. Both are located in the Campos Basin region. The Quipea project has not involved

[15] Further information is available at: https://www.terra.com.br/noticias/tecnologia/inovacoes-tecnologicas/startup-instala-paineis-solares-em-favelas-no-rio-de-janeiro,5fbfe3462069c67545774df9e33b9de5xpmoms01.html

http://g1.globo.com/rio-de-janeiro/noticia/2014/11/startup-do-rio-investe-em-energia-solar-no-morro-dona-marta.html

[16] See more at: https://gender.bitc.org.uk/issues/equal-lives-partnership-santander-uk

[17] Find more about Shell's initiatives on gender, diversity and sustainability at: https://www.shell.com/

specifically gender issues, but diversity more broadly. This project is about supporting *Quilombolas* communities and doing activities, such as, leadership training seminars, community training courses; annual cultural events to strengthen their identity; cultural exchanges and regional meetings to plan next actions that reinforce the sense of belonging.[18]

b) Awards to teachers is another social project from Shell that intends to promote STEM education.[19]

c) "*Mar Atento*" is a project of engagement and training of fishermen/fisherwomen to act in the emergency response with oil spill at sea, which aims at the safety and protection of marine and coastal environments.[20]

d) Solar energy projects in communities are also highlighted such as Santa Marta where electricity is provided to day care centres, churches, the Residents' Association, a music school and the local samba school.[21]

2.2.3 Schneider Electric

Schneider Electric (SE)[22] is a world leading company in energy management and automation, among other business activities. The company has its headquarters in Rueil Malmaison, France, and it is present in 130 nations, including Brazil. The company is included in the **Bloomberg Financial Services Gender-Equality Index (BFGEI)[23].**

The company recruited more than 23,000 women in the past three years. It received the prize HeForShe (a solidarity campaign initiated by UN Women) and has several initiatives to promote diversity worldwide and woman leadership. In 2014, a working group was formed to address the topic of pay equity and the pilots in 12 countries brought findings that helped define a three-year vision to cover 85% of the total workforce under a worldwide pay equity review process by the end of 2017. A Women's Advisory Board was created in the company in 2015, with the governance body composed of 10 top leaders from the three main Schneider Electric geographies, aiming to suggest new initiatives to lead the company towards parity and a culture more sensitive to gender diversity.

The company also had a woman CEO in Brazil, Tania Cosentino (currently at Microsoft), who was the SE Brazil's President and then President for the entire South America Zone until Dec 2018 and gave a special attention for gender issues while working at the company.

[18] See more at: https://www.shell.com.br/sustentabilidade/projetos-e-iniciativas-de-desenvolvimento-sustentavel/quipea.html

[19] See more at: https://www.shell.com.br/sustentabilidade/projetos-e-iniciativas-de-desenvolvimento-sustentavel/Pr%C3%AAmio%20Shell%20de%20Educa%C3%A7%C3%A3o%20Cient%C3%ADfica.html

[20] See more at: https://www.shell.com.br/sustentabilidade/projetos-e-iniciativas-de-desenvolvimento-sustentavel/mar-atento.html

[21] See more at: http://esenergy.com.br/blog/energia-solar-impulsiona-desenvolvimento-social-nas-favelas-do-brasil/

[22] For more information on the Schneider Electric initiatives on energy and gender, visit: https://www.se.com/pt/pt/about-us/news/2018/schneider-electric-incluida-no-indice-de-igualdade-de-genero-de-2018-da-bloomberg.jsp

[23] BFGEI webpage: https://www.bloomberg.com/gei

2.2.4 Initiatives from Public Energy Companies in Brazil

The gender equality programs in public companies are aligned with the Gender and Race Pro-Equity Programme, an initiative of the Federal Government (PNPM – *Política Nacional para Mulheres*) with the partnership of UN Women and the International Labour Organization (ILO). The actions are discussed and ideas exchanges within the Permanent Committee on Gender, Race and Diversity Issues (Cogemmev)[24], coordinated by the Ministry of Mines and Energy (MME). Most of the activities are focus on communication, such as campaigns and awareness. Also, as it includes other issues such as race, sexual harassment and violence against women, as well as diversity more broadly, actions focused on gender equality and women in decision-make positions seems to be less representative.

As shown in Table 3, most of the activities happened in March (International Women's Day), in October (Pink October) and November (Blue November). This is pretty much the core activities of most public companies. Other programmes or specific activities are also listed below.

[24] Comprised of representatives from the following Government bodies and public companies: Ministry of Mines and Energy, Companhia de Pesquisa de Recursos Minerais (CPRM), Centro de Pesquisas de Energia Elétrica (CEPEL), Companhia de Geração Térmica de Energia Elétrica (CGTEE), Centrais Elétricas Brasileiras S.A. (ELETROBRAS), ELETROBRAS subsidiaries (CHESF, FURNAS, ELETROSUL, ELETRONORTE and ELETRONUCLEAR), ITAIPU Binacional, Petróleo Brasileiro S.A. (PETROBRAS) and its subsidiaries (Distribuidora BR, TRANSPETRO and Liquigás).

Table 3: Most common activities related to gender equality in Public Energy Companies.

Energy company	Women's Day	Pink October	Blue November	Paternity leave extension	Breastfeeding room / campaign
Eletrobrás	Video on gender equality and women empowerment	N/A	N/A	20 days	N/A
CEPEL	Magazine and videos on women empowerment	campaign	Lectures	N/A	Breastfeeding room
Chesf	Campaign and lectures	campaign	campaign	20 days	N/A
Eletrobrás Distribuição Acre	Video	campaign	campaign	N/A	Breastfeeding room and campaigns
Eletrobrás Distribuição Alagoas	N/A	campaign	campaign	N/A	N/A
Eletrobrás Distribuição Rondônia	N/A	campaign	campaign	N/A	N/A
Eletrobrás Distribuição Amazonas	Workshops on gender equality and women empowerment	campaign	N/A	N/A	N/A
Eletrobrás Eletronorte	Lecture	-	N/A	N/A	N/A
Eletrobrás Eletronuclear	N/A	campaign	N/A	N/A	N/A
Eletrosul	Cultural activities	campaign	campaign	20 days	campaign
Furnas	Campaigns, workshops and lectures	campaign	campaign	N/A	N/A
Petrobras	N/A	N/A	N/A	20 days	24 rooms in total and a reduction of 2 hours in the daily working ours for breastfeeding at home.

Some additional activities of the Brazilian public energy companies, beyond those listed in Table 3, are described below. In general, the lack of public information regarding database and percentage of women employees in public energy companies prevented us to assess in further depth the impact of the companies' actions on women's empowerment and participation within each specific company. It would be useful to assess the effectiveness of these activities at company level in future studies. Hence, a programme to assess this information should be preferably done in partnership with the MME's COGEMMEV, especially because some information may be restricted for internal use only.

It is worth noting that, Itaipu and Petrobras were pioneers in gender equality initiatives, bringing international initiatives to the country, such as UN programmes on gender equality and the WEP prize. These companies "opened the doors" on such initiatives to the other public companies.

ELETROBRAS[25]

- The company developed targets for women's career advancement in the company, under the "Business and Management Plan" (2018-2022). For the first time, Eletrobrás included these targets in their management and socio-environmental criteria. The company created and will monitor an indicator: % of women in decision making positions and will work to get parity with the percentage of women working in the company. As it became official, it is seen as an important progress in the commitment from the company's Executives to support gender equality. As it is a new plan, no impacts has been accessed yet. In total, the company has 18% of women employees.
- Campaigns to support gender equality in specific careers within the power sector, targeting girls and women at schools and universities. The idea is to incentivise girls to undertake careers in the STEM area.

ELETROBRAS' ELETRONORTE[26]

- As part of the Gender and Race Pro-Equity Program Eletronorte created the "*Programa Eletronorte de Equidade de Gênero e Diversidade*" – PEEGD. This includes: a) training of multipliers to disseminate info related to harassment, discrimination and other type of "violence" in the work environment; and b) Development of a guideline for broader awareness of these issues.

ELETROBRAS' ELETRONUCLEAR[27]

- Support to the first "*Feira da Diversidade para Capacitação e Empregabilidade*". Targeting capacity building on gender diversity.
- Capacity building on women empowerment – training to all women in managerial positions, from the headquarter in Angra dos Reis.

[25] http://eletrobras.com/pt/Paginas/Equidade-de-Genero-e-Raca-e-Diversidade.aspx

[26] http://www.eln.gov.br/opencms/opencms/imprensa/pro_equidade/equidade_genero.html

[27] http://www.eletronuclear.gov.br/Sociedade-e-Meio-Ambiente/Paginas/Genero-e-Raca.aspx

- Lectures on gender equality and opportunities in the nuclear sector for high school students to encourage young women's interest in careers in nuclear energy.

ELETROBRAS' ELETROSUL

- Actions towards women empowerment through an opinion research with employees. Data collected has been used to plan actions. There is no public information on the percentage of female employees; which prevents us to assess the impact of the company's actions on women empowerement within the company.
- Actions on gender equality from Eletrobras include: general training on gender equality; Partnership with the NGO "Inspiring Girls" on actions to promote interaction between students and women working in the energy field (often seen as man's career) to inspire the students to undertake STEM careers; and Workshop to discuss gender equality with employees, interns and "*menores aprendizes*" (type of internship for students age 14 to 17).
- In 2010 Eletrosul, aligned with Eletrobras, joined the Women Empowerment Principles Declaration, established by the UN Women and the Global Pact. Again, the lack of information and database on the number of women employed prevents us to undertake an impact assessment of this action.

ELETROBRAS' FURNAS[28]

- Furnas supports important forums, workshop and meetings promoting gender equality, such as: a. Forum "*Mulheres em Destaque*" - to incentivise companies to build an environment of women's empowerment. The largest meeting of leaders engaged in gender equality; and b. Forum "*Gestão de Diversidade e Inclusão*" – engaging key Brazilian specialists to discuss the great challenge for the companies and other organizations to Diversity Management and inclusion.
- Meetings with women entrepreneurs organized by the "*Rede Mulher Empreendedora*" targeting the leading role of women.
- Video about career opportunities, disseminated in public schools – interviews with Furnas employees and interns on gender equality – mainly about prejudice against women from family and colleagues at work.
- The company develops activities on a number of gender related issues, such as sexual harassment, women's health, prevention of disease, violence against woman, etc., although not necessarily related to gender equality in the workplace.

ITAIPU Binacional[29]

- Itaipu is a benchmark on the power sector for actions on the gender equality agenda. The company's Gender Equality Inventive Programme, created in 2003, to improve women's

[28] http://www.furnas.com.br/frmSUEquidadeGeneroRaca.aspx

[29] https://www.itaipu.gov.br/en/social-responsibility/gender-equality

rights at work offers an equal opportunities environment. It encourages career advancements to women's employee and opportunities to take on leadership positions. As a result, the number of women in managerial positions has doubled over the last ten years from 10% to 21%. Under the programme the company also promotes initiatives such as flexible working hours, which allows employees with children to anticipate or postpone their shifts in half an hour.

- In order to implement this programme with a real impact to employees, the company heard suggestions from approximately 450 women employees and associates. The programme also includes training workshops for women community leaders in Curitiba and Foz do Iguaçu, and is part of the Ministry of Mines and Energy's Diversity Committee.
- In 2015, Itaipu received, for the fifth time, the Pro-Gender Equality Seal. Created by the Special Office for Women's Policies, the seal acknowledges the innovative work developed by the company in the power industry.
- Aligned with global activities, Itaipu participates since 2010 in the WEPs – Women's Empowerment Principles, having created the prize WEPs Brazil.
- Since 2011, Itaipu Binacional coordinates the Working Group for Human Rights and Work in the Brazil's Global Pact. This group has developed projects to empower women. So far, 350 women participated in the Project.
- Itaipu actively participates in the "HeforShe", a Solidarity Movement for Gender Equality, integrating the committee. In addition, through a partnership with the UN Women, Itaipu develops a capacity-building programme for managers and Project managers aiming at gender equality.
- In March 2017, the company participated in Women's Empowerment Principles Forum Measuring Success, Making it Count: Business Investing in Women and Girls (in NY), with participation in the panel "What Gets Measured Gets Done – Partnerships for Progress".

PETROBRAS[30]

- Petrobras was pioneer in bringing gender equality programmes to the sector, particularly those from the UN system. It was probably due to its international interface and partnerships with other multinational companies. One advantage of the company is its disclosure of information for the external public, including the quantitative data on female and male employees, through its sustainability report. The idea is to demonstrate transparency and the evolution of the improvements on the gender agenda. It includes also information on salaries. The Sustainability report is an important tool to assess progress from the company's gender policies. The progress made in the past had less impact than what the company intended. As gender equality is considered one of the priority themes for Petrobras, the company has decided to accelerate its progress, by recently announcing

[30] http://www.petrobras.com.br/pt/sociedade-e-meio-ambiente/sociedade/apoio-a-principios-e-iniciativas/
http://www.petrobras.com.br/pt/sociedade-e-meio-ambiente/sociedade/politica-de-responsabilidade-social/

a target of increase in 40% women's participation in the company, from the current 18% to 25% in 2025. The company has around 47 thousand employees.

- Since 2011, the company started to develop specific uniforms for women in operational areas. In the past uniforms were unisex. The company understand that the adaptation of traditional uniforms brings more comfort, emotional safety, well-being and productivity to woman.
- The company also promotes campaigns with videos, debates and lecture son the challenges for women on the modern society, gender equality and pregnancy.
- The company created a permanent channel for complaints and disclosure against discrimination of any type – gender, race, sexuality, and religion.
- For five times the company received the Pro-Equity Gender and Race seal.

2.3 Other Initiatives on Energy & Gender in Brazil

A pioneering initiative on women's organisation is the **Map of Women's Collectives (MAMU)**[31]. It is comprised of a large number of independent collaborative initiatives, so-called "*coletivos*", working on several different topics across the Brazil. Although there is no topic designated specifically to energy issues, there are some related concerns within several organisations involved, such as: entrepreneurship, education, financing, women's rights, university, solidary economy, and technology. According to its website, the objective of this project is "to give visibility to these spaces, to value them, to facilitate the access of the public that seeks them, to seek support, to foster networks, to discuss, to propose partnerships, to allow them to recognize themselves in this context, to embrace and to be happy!" Some groups are only virtual, while others have a physical location.

The following sections show several initiatives on energy access to vulnerable communities in Brazil, with potential implications on women lives.

2.3.1 COHAB's Solar Project in Curitiba

In 2018, 26 houses of a popular housing complex made through COHAB in Curitiba received photovoltaic panels installed by the local electricity distribution company, COPEL. The panels are generating significant decreases in residents' electricity bills, with reductions exceeding 80%. The equipment allows the energy produced to be redirected to the grid, and the results have already appeared on the energy bills. Savings reported by the residents are between 55-84%, which have incentivised the use the money saved to invest on home improvements (Prefeitura de Curitiba, 2018). These investments generate benefits for all family members, by improving quality of life more broadly, especially for women (and their children), who are more often responsible for household activities in patriarchal societies.

[31] See more about MAMU at: http://www.mamu.net.br/

2.3.2 "Litro de Luz" Project in the Quilombola's Community of Prata

The quilombola settlement "*Comunidade do Prata*" does not have access to electricity and sanitation network infrastructure. The community counts with almost no generator (except by three families) and uses candles and kerosene lanterns, facing the health risks of smoke. In order to reduce the vulnerability of local people, Agehab (Goiás State Housing Agency) has created a partnership with the NGOs "Litro de Luz" and "Na Praia". The action mobilised more than 30 volunteers from across the country to work together bringing light to more than 600 people. 57 posts were installed, and more than 80 lamps were distributed, both supplied with solar energy (Fonseca, 2019).

2.3.3 Other "Litro de Luz" projects

AMAZON – The NGO in partnership with the Association of Rural Producers of Carauari (ASPROC) helped 50 riverine communities in Amazon with sustainable solar energy. 15 days of action counting with volunteers and residents have built 600 lanterns, directly impacting 3,000 people.

SANTA CATARINA - In 2017, Litro de Luz brought light to the indigenous community of Morro dos Cavalos, located in the municipality of Palhoças. Residents and volunteers urged 28 solar poles, impacting about 200 people.

FEDERAL DISTRICT - Appointed as one of the largest favela in Brazil, with about 80 thousand inhabitants, Sol Nascente, in Ceilândia, in the Federal District, had dozens of alleyways without lights. In 2016, Litro de Luz, with the help of the residents, installed 30 solar powered posts, impacting about 200 residents[32].

2.3.4 Solar energy in school and laboratory in the State of Amazonas

A malaria diagnostic laboratory in the Boa Esperança community, located in Reserva Amanã, States of Amazonas, was contemplated in 2004 with a solar energy kit to reduce the dependency on diesel availability. This initiative was implemented by Mamirauá Institute[33] and residents, financed by Mamirauá Civil Society, InSight Light and the Ministry of Science, Technology and Innovation. The community system - which consists of a 75 W photovoltaic solar panel, a 150 Ah battery and a 300W inverter - has benefited about 100 families in five communities.

Also, in 2013, a solar photovoltaic lighting system - consisting of a controller, a 110 Watts module, a 150 Ah battery and four lamps - was installed in Bom Jesus do Baré community, attending to the functioning of classes at night for the literacy of youth and adults[34] (Mamirauá, 2019). This programme has been led by Mamirauá Institute, supported by the communities of Amamã Reserve

[32] See more at: https://www.litrodeluz.com/.

[33] Instituto Mamirauá is a Social Organisation (OS) supervised by the Brazilian Ministry of Science, Technology, Innovation and Communications (MCTIC). In Brazil, an OS is a kind of NGO legally supervised by a governmental institution.

[34] See more at: https://www.mamiraua.org.br/pt-br/tecnologias-sociais/energia-solar-para-escola-e-laboratorio/

of Sustainable Development, and funded by Fundo Amazônia, Moore Foundation, Sociedade Civil Mamirauá, FAPEAM, Government of the State of Amazonas, and Federal Government.

2.3.5 Residential solar systems in an Amazonian riverside community

Between 2005 and 2007, 23 home photovoltaic systems (HPS) were installed in São Francisco de Aiucá, located in the Mamirauá Sustainable Development Reserve in the State of Amazonas. The project was an initiative of the Laboratory of Photovoltaic Systems of the Institute of Electrotechnology and Energy (IEE) of the University of São Paulo (USP), the Mamirauá Sustainable Development Institute and the Winrock International Institute. The HPSs guarantee the supply of 13 kWh of electricity per month and most users qualified photovoltaic energy as good or very good, due to its advantages over diesel-based generation, avoiding smokes and noise. The perceived benefits include the possibility of better lighting, being able to watch television, listening to music and reducing their pantries in candles, batteries and fuel for lamps (Morales *et al*., 2012). The solar panels were installed in compliance with ANEEL Resolution no. 83/2004.

Since the implementation of this project, the communities have been supplied with renewable energy, and followed up by Mamirauá Institute. This project could be replicated to other communities under similar conditions. Further information is available online[35].

2.3.6 Solar energy to an extractive community in the Amazon

In 2017, four systems of the first phase of the project "Resex Produtoras de Energia Limpa" were installed, all in extractive reserves located in Lábrea (AM), Ituxi and Medio Purus. The project is a partnership between ICMBio and WWF aimed to improve community's life. At Resex Ituxi, three systems were installed for well water pumping, refrigeration and use of productive equipment. The first machine that ran in the solar powered community was a stripper, used for açaí production, which represents an important potential in the region. When the pulper is not in use, the solar energy can be used by the local health agent who controls malaria using equipment such as a microscope, as well as other community's needs such as radio and cellular charging, for example. With the pumping system, the entire community can have water for individual and collective use, as well as the cleaning of açaí and cassava production.

At Resex Medio Purus, where there are 97 communities and more than 5,500 residents, the second solar system of the project was installed, helping to bring clean water to the houses. At the Resex Medio Purus the first photovoltaic system was installed in a school that serves about 60 students, turning the school able to count on evening classes and other benefits, such as a fan in classrooms, internet access and adequate lighting, as well as saving expenses on fuel used to generate energy. The project included a capacity building programme. The idea is to expand the initiative. Further

[35] For more information about the Mamirauá project, access: https://www.mamiraua.org.br/projeto-tecnologias-sociais-sistemas-fotovoltaicos-domiciliares

information is available online[36]. The British Embassy, for example, could potentially help this initiative to scale up further, in collaboration with the players already involved, particularly ICMBio.

Data released by the implementing organisation show that a solar system of 0.8 kW in the Amazon generates, on average, 4 kwh per day or 1,460 kWh in a year. This volume avoids the burning of 489 litters of diesel and the emission of at least 1,300 kilograms of carbon dioxide into the atmosphere (ICMBio, 2017; Brito, 2018).

2.4 International cases with potential application in Brazil

This section shows a brief assessment of some relevant international case studies that could be potentially "adopted and adapted" in Brazil. Differently from the usual programmes in Brazil all the cases here shown build on the idea of having women involved and on bringing sustainable energy. This perspective either is absent or it is not central in the current Brazilian funding for the low carbon energies.

For example, there is still a lack of access to modern cookstoves in many communities in the country, and some international cases offer good insights to inspire initiatives in Brazil to avoid the effects to women's health due to biomass gathering and burn for food preparation. The Clean Cooking Alliance, for instance, was stablished in 2010 focused on disseminating the access to clean cooking facilities around the world. This American initiative has three pillars: driving consumer demand for cleaner and more modern stoves and fuels by supporting behavioural change and awareness raising interventions; building a pipeline of investable businesses capable of delivering affordable, appropriate, high-quality clean cooking products; and fostering an enabling environment for industry growth by advocating for effective and predictable policies, providing trusted, relevant data. On the other hand, the use of liquefied petroleum gas (LPG) is the most common source of energy for cooking in Brazil. LPG is largely disseminated across the country, and Brazil is also a reference in the use of bioenergy. However, lessons can always be learnt from international experiences. With Brazil's potential for increasing the share of renewables, there is an opportunity for integrating women's perspectives to new policies and projects.

Another initiative is TIDE (Technology Informatics Design Endeavour), an Indian NGO aimed to identify and/or adapt technologies developed in various laboratories in order to disseminate them to communities, with programmes related to energy efficiency, energy conservation, women and livelihood, cookstoves, water and environment. With more than 250 projects, TIDE's methodology has been profiled as Best Practices by UNDP in the area of energy access to low-income population. In an acclaimed initiative, the NGO has adapted cookstoves based on conversations with women in India's rural areas and has disseminated, in a strategic way, the stoves designed to meet women's needs. This action was conceived and executed by women and implemented without subsidy or government intervention.

The World Bank Group has supported similar programmes worldwide, even though its main objective was related to halt deforestation. PROGEDE 1, for example, was the Senegal Sustainable and Participatory Energy Management Project implemented in the period of 1997-2004 with the

[36] See more about this project in Resex Medio Purus at: http://www.icmbio.gov.br/portal/ultimas-noticias/20-geral/9028-energia-solar-ilumina-uc-na-amazonia

objective of combating Senegal's rapidly growing demand for household fuels and the degradation of forests and the rural environment. This project has promoted an increase in the availability of traditional fuels in a sustainable manner while boosting household incomes and preserving forest ecosystems, also aiming inter-fuel substitution in the private sector and NGO-based initiatives to spread the use of improved cookstoves. The success of PRGEDE 1 has led to the creation of PROGEDE 2 from 2010-2018, sponsored by the World Bank and Nordic Development Fund, which has included the gender perspective in the energy project.

Brazil has a history of short-term initiatives and the PROGEDE initiatives show that results in the gender energy sector require long-term programmes. These initiatives created opportunities for women in decision-making processes, skill development in technical production, entrepreneurship and organisational management, and with increased incomes. Incentives to women entrepreneurship can also bring economic benefits to families in rural areas. A project to integrate agriculture in National Adaptation Plan, supported by FAO, UNDP and Uganda Government, started in 2010, created a good income opportunity for women in Uganda. Originally, the idea was a post-harvest programme with recommendations of small-scale solar dryers for long-term storage and household consumption of fruit and vegetables. However, the food security concern turned into a profitable activity for women in Uganda, whose created a company for selling dried fruits in 1992. The Fruits of the Nile (FON) buys organic sun-dried pineapple and banana from farmers groups in Uganda which are part of the Fruits of the Nile Growers Association (FONA). This association has about 700 members. The implementation of similar solar dryers in some rural areas of Brazil could also be helpful, as well as for water pumping, refrigeration and other uses. Women in these areas are often responsible for growing the food for the family and the use of solar energy could help them inprove their quality of life.

Moreover, the World Bank Group and more 18 entities created an initiative called Energy Sector Management Assistance Programme (ESMAP), which applies the gender perspective in the Africa Renewable Energy and Access (AFREA) programme. Since 2009, AFREA aims to energy access, green growth and capacity building in Africa. The Gender and Energy Programme has been supporting activities in Senegal, Mali, Benin, Tanzania, Kenya and Zambia, and has piloted approaches, developed analytical resources, working with energy teams and government clients on integrating gender into existing and new energy access operations. These programmes indicate that the bridge between the energy providers and the population has to involve women on each side of the negotiation which has not been done in Brazil yet.

There is a diversity of international initiatives summarised in Table 4. They share two main characteristics which should also be addressed in initiatives alike in Brazil: they focus on energy use in which women are involved, resulting on benefits of health, time and quality of life more broadly; and they focus on the women's empowerment at the community level. These two characteristics are absent in the usual policies of Brazil, which focus on large-scale projects without an associated gender policy.

Table 4: International case studies on energy & gender equality.

Initiative	Where	Purpose	Example	Source / Webpage
ECOW-GEN	Mano River Union (MRU) – Cote d'Ivoire, Guinea, Liberia and Sierra Leone.	Training in gender and energy policies; clean energy projects are funded.	The production facility for liquefied petroleum gas (LPG) inaugurated in Tema, Ghana, on 4 August 2016. The facility is a product of the ANOMENA-ECOWAS Women's Business Fund project "Promotion of ANOMENA Improved LPG Stoves as a Clean Energy Initiative for Cooking", working towards contributing to the nation's effort to reduce her dependence on solid fuels for cooking.	http://ecowgen.ecreee.org http://www.ecowrex.org/system/files/ecow-gen_programme_document_2015-2019_final_vf_en.pdf
UNDP Project: Solar Engineers	The initiative has expanded to 18 countries. As a result, 71 women have been trained as solar engineers, who electrified 3,778 households in 52 villages. Women and girls especially have benefited as they are now able to devote more time to education and income-generating activities.	Train women to install solar cells in homes, therefore girls can study and women can work. The training involves women from the poor communities even when they do not have education.	Back home in Honduras, Marlene, Carmen, Alnora and Ingrid are sharing what they learned with other members of their communities. Together they're making sure their own children and their neighbours' children will get a chance to learn to read and write.	https://stories.undp.org/honduran-women-light-the-way
UNDP Project: Solar Pumps Africa	Cabo Verde, Cambodia, Mali, Niger and Sudan.	Project with support from Canada with solar-powered water supply. The idea is to provide water for irrigation using solar energy.	In Cambodia user groups have been formed to manage water resources, putting women in leadership positions. This led to positive changes, such as reduced tensions between women and men, shared decision-making and increased skills for women.	https://stories.undp.org/solar-empowerment-across-countries
UNDP Project: Mali's Women Adapt to Climate Change	Mali	Train women to change the production by adapting to climate change in the type of crops to be produced.	Massantola, the project has supported Diarra's cooperative to clear a plot for gardening and provide access to water. A solar-powered platform was provided to the women's collective, to help process grain into flour, a very time-intensive process necessary for cooking.	https://stories.undp.org/supporting-malis-women-to-adapt-to-climate-change
ENERGIA - Women's Economic Empowerment	22 African and Asian countries.	Scaling up the delivery of energy products and services, using the women network for: the connection and development of the enterprises, advocating a change in policies and practices and incorporating gender lens to the solutions of energy issues.	See Figure A1 in Appendix.	https://www.energia.org/what-we-do/womens-economic-empowerment/

Initiative	Where	Purpose	Example	Source / Webpage
Earth Spark International's Feminist Electrification	Rural areas in developing nations.	To provide affordable, clean and safe electricity to communities with energy access.	"EarthSpark's 'Feminist Electrification' makes sure women are represented and involved at all levels of energy system planning and operations". The initiative is carried out in collaboration with ENERGIA.	http://www.earthsparkinternational.org/blog/feminist-electrification
Practical Action	Africa, Latin America and Asia	Practical Action supports small scale projects and one of the topics is to help locally to provide energy.	Practical Action promotes small-scale hydro schemes that generate up to 500 kilowatts of power. The micro-hydro power station, which converts the energy of flowing water into electricity, provides poor communities in rural areas with an affordable, easy to maintain and long-term solution to their energy needs. Using the overabundance of sunshine, the solar pump draws water from a 100-metre-deep well, providing families with the water that they desperately need and rendering cases of water-related diseases a thing of the past. By working with the communities in the heart of Turkana, Practical Action partnered with local people to develop a sustainable solution to the endless problems caused by drought. A solar-powered water pump that uses locally-sourced equipment to pump 30,000 clean litres of clean, safe water to the village every day was developed. These new pumps mean the villagers in Turkana, have access to clean, safe water every day, and they know they can drink in safety.	https://practicalaction.org/
Solar Sisters	Rural Africa	To empower women through social enterprise for eradicating energy poverty at scale by investing in women as clean energy entrepreneurs and leaders.	Solar Lantern program brings light to homes. See Figure A2 in Appendix.	https://solarsister.org https://static1.squarespace.com/static/581b86d58419c2b663a87d5a/t/594196eb8419c2bc4a837d0d/1497470711855/Turning-on-the-Lights-Miller-Center.FINAL.033017+(1).pdf

Source: prepared by the authors, using references with links cited within the table.

Chapter 3: Results from the interviews

This chapter provides a summary of the discussions with selected stakeholders from the energy sector (including business and academic roles). The contacts were carried out via in-person meetings[37] and online questionnaire[38]. A list of acknowledgements for all the participants involved is available in the end of this report (Table 5), without attributing their comments or institutions to the views presented in the text. The stakeholders' identities are not mentioned in the discussions for privacy reasons, in line with the Chatham House rule[39].

Question 1: What is your view about the participation of women in the energy sector, from formation at undergraduate level to the occupation of decision-making positions? Do you have any data about that?

Most stakeholders commented that the participation of women in the energy sector is still very small, mainly in decision-making and operational roles. Although some progress was done, the general perception is that the energy sector shows strong gender inequality. Some consider the sector "old and conservative", full of male engineers, with no team recycling. Leadership positions are dominated by "white man over 50 years old". Usually female engineers undertake technical positions, not leadership roles. An expert mentioned that there are more women working on energy generation and commercialisation, and less on distribution, which is a more conservative sector. There is a general perception that the number of women in energy-related technical courses has increased, but it is still far from ideal. In postgraduate courses related to energy at the University of São Paulo (USP), for instance, currently about 39% of students are women. An oil and gas expert noted that in chemical engineering undergraduate courses, the share of men and women is approximately 50/50. Similarly, an expert from the electricity sector mentioned that the participation of women in energy debates has increased over time.

It is important to note that public companies hire its personnel through official application exams ("*concurso público*") and, therefore, a quota system may be helpful to ensure a higher diversity in these companies. Some experts informed that the companies work internally on the gender equality agenda through the "Pro-Equity of Gender and Race" programme from the Federal Government. In this sense, there has been an increase in the number of women holding leadership positions over the years, which is monitored by the company's Gender, Race and Diversity Committee, as also noted in the interviews.

Another expert commented that, in the Brazilian universities, gender issues are not considered in the selection of research projects, whereas in the United States this is a common practice. Some mentioned that the opportunities for women in the energy sector are few. For a stakeholder there are many well-prepared women available and looking for a job in this area. The challenge is to increase women in decision-making roles. Most of companies do not follow up with these changes

[37] The in-person conversations were intentionally informal and, therefore, the summary here shown is an interpretation of the project's authors.

[38] The original questionnaire is available in Portuguese version in the Appendix.

[39] The Chatham House rule is available at: https://www.chathamhouse.org/chatham-house-rule

more substantially. MME, in contrast, has some data about women in energy, not only for those working at the Ministry but also at its affiliated companies.

Some approximate figures for women's participation at the Brazilian Electricity Regulatory Agency (ANEEL) were cited. Women occupy about 30% of the total jobs in the agency, and the concentration is higher in technical-administrative positions (48%) and for Analysts (41%). For the role of Regulation Specialist, women are just 17%, whereas for commissioned posts ("*cargo comissionado*") women represent between 27% and 31%, which is similar to their participation in total staff. In the board of directors ("Diretoria Colegiada") there is one female director and four male directors, and she is the second director in 20 years, since the creation of ANEEL. Similarly, in its 24 Organisational Units, ANEEL has only one woman managing the area as its main representative, and three as deputy-representatives.

Question 2: Have you followed initiatives about the professional insertion of women in the energy sector? If so, could you cite them?

Many interviewees were not aware of initiatives on energy & gender in their institutions. However, some examples were mentioned, such as: a. an initiative supported by the Embassy of Austria in Brazil called "Women for Energy Transition"; b. a group called "Damas da Energia" (Ladies of Energy), considered a useful network; c. Petrobras' project concerning women in STEM careers; d. The Brazilian National Committee for the Production and Transmission of Electric Energy (CIGRÉ-Brasil)[40]. A stakeholder mentioned that she has followed informal initiatives from women working on the energy sector, who seek to fill job vacancies with women's CVs through their network of contacts. In addition, they meet periodically to address the issue and identify possible actions for the professional insertion of more women.

Eletrobras was also cited to have joined national and international policies and agreements, such as the Programme for Pro-Equity of Gender and Race at the Federal Government, Principles for Women Empowerment, and the Global Pact. The company has a seat at the MME's COGEMMEV. It has targets for the advancement of women to management positions, as described in its Business and Management Master Plan. It also supports social projects with gender perspectives and develops activities in schools with students to avoid gender stereotypes. In addition, Eletrobras implements actions and policies of extension to maternity and paternity leave, among other initiatives.

An interviewee commented that she has been following initiatives at the MME, ANEEL and training courses for women in academia and companies. COGEMMEV under the MME was also cited by two participants. MME has currently its first Executive Secretary since its creation, while former-President Dilma Rousseff was its first Minister of State in history. It was also noted that there are currently more women working on energy transmission and oil platforms, including with personal protective equipment (EPI – *Equipamento de Proteção Individual*) designed for women. The initiative "*Sim, Elas Existem*" (Yes, They Exist) was also cited by another interviewee.

[40] CIGRE-Brasil website: http://www.cigre.org.br

Question 3: Does your institution have initiatives on gender equality? If so, could you describe them?

Many interviewees mentioned that most initiatives, in gender equality, occur in the public sector. The Ministry of Mines and Energy (MME) has a Permanent Committee on Gender, Race and Diversity Issues (COGEMMEV) for 14 years. Currently, there are 21 entities involved, including the Ministry and its affiliated institutions (public energy companies and governmental bodies at federal level). COGEMMEV has been promoting the establishment of Diversity Committees focused on gender and race, as well as promoting the launch, in the first half of 2019, of a Strategic Plan aimed at serving as the guideline, for the public companies, for gender and race policy for the next 4 years (2020-2024) in the Brazilian energy sector. Besides, some staff from MME also recently organised an initiative called "sim, elas existem" (yes, they exist), as already discussed, in order to promote the hiring of woman professionals for energy roles in high-level positions. A stakeholder mentioned groups in the University of São Paulo discussing the inclusion of women in science, such as "Girls in Science"[41].

The Electric Energy Trading Chamber (CCEE) has been monitoring the percentage of women in leading roles. The Chamber has been recognising both women and men's achievements, but it has as a specific goal of increasing women's participation in its activities. In addition, ENEL, the Italian multinational energy company, was cited to have an international programme for women's inclusion in energy sector positions across 32 nations. Eletrobras has the Programme of Community Production Centres (*Programa de Centros Comunitários de Produção*), which supports small producers and family farmers and, whenever possible, it seeks to encourage initiatives that empower women for economic autonomy. Moreover, ANEEL has carried out activities focused on gender equality, but they are still isolated actions that are not part of a broader and integrated planning. This may change soon, as it is in the process of creating its Internal Committee on Gender, Race and Diversity.

Question 4: Does your institution work on social projects in the energy sector involving low-income communities, isolated areas, rural areas, or initiatives alike? Do these projects try to involve women?

When it comes to social projects supported by energy companies, many participants confirmed that their institutions do have such social projects. Apparently, there are many initiatives in this regard in Brazil, but just a few interviewees were able to provide further information on it. One expert mentioned none of their social projects has focus on women's inclusion. Another person commented about an initiative to help attend low-income families impacted by the installation of electricity transmission lines. In these electricity projects, houses were demolished, and families endured various losses. The groups of representation are usually led by women. The idea is to resettle these communities in other areas with dignity. CTEEP (*Companhia de Transmissão de Energia Elétrica Paulista*) has participated in this initiative too.

[41] See more at: http://www.io.usp.br/index.php/noticias/1118-titulo-meninas-com-ciencia-2a-edicao-sp-de-mulheres-cientistas-para-meninas-que-sonham-2

An interviewee cited an international project for the sustainable expansion of sugarcane energy in Latin America, the Caribbean and Africa (LACAf Project)[42], supported by FAPESP (São Paulo Research Foundation). Part of the project was about the use of modern ethanol cookstoves vs. traditional woodfire-based cookstoves in rural areas, reducing respiratory problems, especially for women in African nations.

The "Light for All" programme, as previously described in this report, was mentioned as the most important initiative to provide affordable and clean energy to low income communities, with impact on women. Furthermore, each MME's affiliated energy companies (usually public companies with mixed capital: private and public) carries out their own social projects and some of them have a gender perspective.

Private energy companies are also involved in many social projects, including in renewable energies, although not necessarily related to gender equality. Light S.A., for example, was mentioned for working on social projects in Rio's favelas aiming at reducing energy losses due to irregular connections (illegal use) to the electricity grid. This project indirectly helped the communities, especially women, by providing clean, safe and affordable energy access, whilst also reducing expenses for a legal energy inclusion (see further discussions in the Light's case study of this report).

Question 5: As a woman working at the energy sector, what suggestions would you give in terms of formation so that women could work and progress in the area?

Many participants argue on the need for capacity building programmes in leadership and management. Some companies, such as *KPMG* and information technology companies were mentioned as successful references on those type of programmes. Others believe women should be incentivised to take more STEM courses. Another expert commented that people with strong technical backgrounds have advantages to prosper in the energy sector, and that gradually these people gain reputation and space.

Concerning women formation initiatives, it was commented that the gender gap in engineering courses is due to the discouraging prospect of the labour market and the patriarch corporate environment in Brazil. Thus, the original problem is not training per se. Companies should be more aware of these issues, since the recruitment process for internship programmes in order to include more women in this sector and ensure their development up to leadership positions.

In terms of Human Resources, an interviewee suggested that companies should have a plan of targets for gender equality, in order to achieve a higher percentage of women in underrepresented positions, especially decision-making roles. In her view, the use of gender quotas is also an option, but systems based on temporal targets are often more easily accepted by companies, including large corporations. However, another participant considers quota for women's participation in the energy sector an important measure to help improve energy equality in this sector.

Some experts commented about the importance of groups of networking to empower women in the energy sector, as well as professional coaching that could help women progress in their careers. Also, it is important to encourage girls from high school to undertake more STEM courses. The MME

[42] Insights from the LACAf project were recently published as a book, see Cortez *et al*. (2018), involving several authors from Brazil and abroad.

Cogemmev's Strategic Planning has invested in the development of trainings for promoting employees, including on women's leadership, as well as training for all staff to raise awareness on the following themes: gender, race and harassment, among others. Some have also suggested the importance of partnership with schools, universities and NGOs for capacity building programmes.

Question 6: In your opinion, how could the British Embassy contribute to gender equality in the energy sector in Brazil? Would you have any suggestions of concrete initiatives?

Most interviewees suggested capacity building programmes and other initiatives such as: exchange of experiences (academic or public policies), short courses, awards/prizes, mentoring programmes, research programmes and scholarships. Another suggestion was about to provide financial support for the development of energy projects coordinated by female researchers, and hence contributing for women's empowerment in this sector. An interviewee commented that, if the British Embassy carries out one of its prospective projects about creating a new “energy centre”, then this centre could also promote energy & gender initiatives and have an internal gender equality policy for recruiting its internal staff as well.

The Embassy was invited to support the initiatives of the MME’s COGEMMEV, considering the diversity of its scope in the sectors of energy, mining, oil and gas, the changes of management processes that may be provoked, and the number of women that its projects can influence.

An interviewee suggested the Embassy to adopt gender equality indicators for all its funded projects. Similarly, another participant recommended to carry out a monitoring programme, requiring data in the application forms for research and development (R&D) projects and a questionnaire for companies, awarding those with the best results.

Question 7: Would you have any other comments or suggestions to the project, including case studies for our knowledge and analysis, whether in the public or private sector?

An expert suggested the creation of a programme that would enable small-scale immersions of girls in companies in the electricity sector, for example, watching videos, lectures and even watching some of the work there. According to a stakeholder, in her view, women usually have discipline and look for knowledge before attending professional appointments.

It is a common sense that, despite women’s increased participation in the job market, their career development in their institutions is still an issue. The internal promotion systems are usually unfair, and women rarely reach the very top positions in the hierarchy. Besides, the recruitment system is often biased.

In conclusion, interviewees consider the energy sector quite conservative. Some progress was made, however, there is a lot to be done yet. Some energy institutions were cited for knowledge as references on initiatives about energy & gender, such as: a. the Brazilian Institute of Petroleum, Natural Gas and Biofuels (IBP), which has a mentoring programme for diversity; b. Petrobras and Eletrobras, both which transparency and good programme for gender equality; and c. the Brazilian Government’s National School of Public Administration (ENAP), which has an executive training programme for women in leadership.

Chapter 4: Actions and indicators for energy & gender in the context of the UK Prosperity Fund

This section presents an overview on proposed actions and indicators for promoting gender equality in the Brazilian energy sector, which may be useful for future initiatives supported by the British Embassy in Brazil. The activities here shown may involve different players, and the British Embassy is encouraged to support them whenever appropriate. In general, the MME's Cogemmev may serve as an important platform for dialoguing with the energy sector on gender issues nationwide.

4.1. Proposed actions in energy companies

Based on our literature review, especially Hunt *et al.* (2018) and the Women's Empowerment Principles[43], international experiences and research developed in Brazil, including interviews with key stakeholders, we suggest some key actions for a successful gender equality strategy in energy corporations. The proposed actions are to:

1) Obtain a high-level commitment to gender equality programmes and initiatives starting from the top positions in the corporations. In order to have a successful implementation, the programme needs CEO support to cascade the commitment throughout the company;

2) Prepare a well-structured assessment of the main bottlenecks that may be preventing gender equality in the company;

3) Define gender equality priorities based on what drives the company's business growth strategy. It should include in-company research to understand the personnel's needs for guiding a viable gender equality strategy.

4) Disclosure information on gender indicators, through public progress reports aimed to achieve gender equality over time. The indicators must be periodically accompanied and monitored against the company's goals.

5) Establish a quota system or a corporate target programme is important to speed up the promotion of gender equality. The creation of a targeted portfolio should state priorities in line with the company's overall growth strategy and principles.

6) Carry out a capacity building programme for women, including training and professional development for women's career advancement.

7) Ensure a work environment with equal opportunities, including health, safety and well-being of all workers (women and man).

[43] https://www.unglobalcompact.org/take-action/action/womens-principles

4.2. Proposed Indicators

Overcoming barriers for gender issues in the Energy sector requires not only recognition of the baseline or the current situation in the country, but also a good monitoring of indicators, in order to support public policies and companies or NGOs' project management. Either quantitative and qualitative indicators are relevant to appraise the level of success and efforts allocation, given that most challenges involve subjective approaches which are difficult to measure. Indicators should be linked to targets, so having a set of objectives based on strong conceptions is fundamental to indicators' effectiveness.

There are many platforms dedicated to gender indicators in the energy sector applicable at the world level, as listed below[44]:

- SDGs – Sustainable Development Goals of the United Nations;
- SE4All under SDG 7 - MultiTier Framework;
- GTF (Global Tracking Framework);
- International Center for Research on Women (ICRW) - social impacts of the clean cooking sector;
- IRENA - Renewable Energy Jobs;
- Wplus – certification of social benefits for investments in women;
- WHO - health national and international, health services and health improvement;
- ENERGIA - gender and energy research programme - evidence and understanding links between energy, gender and poverty.

Based on international efforts to point out how to measure gender equality in the energy sector, this report presents some suggestions of indicators, as a framework potentially applicable to Brazil's conditions at different levels and approaches.

4.2.1. Indicators for policy evaluation

The first set of indicators is addressed to policy evaluation of social and economic impacts of energy access, the quality and availability of fuel sources for households, and in women's health and empowerment, as following described:

- Households with access to electricity;
- Households primarily using clean and efficient cooking fuels and technologies;
- Reduced time spent on unpaid domestic and care tasks due to lack of electricity;
- Increase in time spent by women on skills and vocational training and learning activities;
- Reduced energy expenditure by households;
- Mortality rate attributed to household and ambient air pollution due to biomass use for cooking;
- Women with primary reliance on clean fuels and technology;
- Women having access to renewable energy supplies and non-polluting technologies
- Mean air pollution of particulate matter (PM10 and PM2.5);

[44] Presented by Annemarije Kooijman from ENERGIA – International Network on Gender and Sustainable Energy, at GECCO ENERGIA webinar 21 April 2016.

- Premature deaths attributable to ambient and household air pollution;
- Proportion of households within 15 minutes of fuel and clean water;
- Improvement of health through electricity access, which can improve food conservation (e.g. through the use of refrigerators) and general hygiene conditions;
- Women that resumed or started their studies at night period due to public electricity access;
- Improved primary and/or secondary school enrolment, attendance, and performance for girls and boys;
- Women that entered the labour market or started a productive activity;
- Electricity access impact on the level of education;
- Electricity access impact on security;
- Electricity access impact on the level of employment and income.

4.2.2. Indicators for professional career

In regard to women's career and participation in the energy sector, some potentially useful indicators are following described:

- Share of women in energy companies;
- Share of women in STEM areas;
- Share of women in decision making positions (CEOs, Executive Boards, Boards of Directors and Supervisory Boards).

4.2.3. Indicators for project's assessment

This section provides a set of indicators that are important for project planning and management in the energy sector. The United Nations for Industrial Development Organization (UNIDO) published in 2014 a Guide on Gender Mainstream Energy and Climate Change Projects with some key points for apply gender perspectives on projects implementation at different levels for Government, companies and NGOs, including impacts of the planned actions and the project's management human resources. In order to further identify entry points for integrating gender dimensions into the projects, UNIDO gives important aspects to consider:

- How will women and men be targeted and reached?
- Are there any women's groups, associations or NGOs in the country that the project can partner with?
- Is the project responding to gender-differentiated patterns of division of labour, wage gaps, etc.?
- How will the activities and services of the project benefit women and men?
- Is the project likely to have adverse effects on women or men?
- How will the project affect relations between women and men?
- How will the project ensure women and men have equal access to the opportunities and services that the project provides?
- How can the project ensure and enhance women's participation in the activities or services provided?

In addition, a set of indicators regarding the assessment of the project's impacts is described below:

- Percentage of women and men participants at training sessions;
- Number of workshops that include dedicated gender sessions;
- Percentage of women and men professionals, engineers, technicians for targeted sectors;
- Percentage of technical interventions with high Gender Equality and the Empowerment of Women (GEEW) impact potential;
- Number of impact assessments;
- Number of gender-relevant dialogues facilitated;
- Percentage of women and men trained on new technologies;
- Percentage of women and men working in pilot facilities;
- Number of new/improved technologies for women in sustainable energy;
- Number of gender-specific recommendations concluded from research.

Chapter 5: Conclusions

This report indicates that even though a number of international initiatives have indicated that the participation of women in the energy sector is important, in Brazil this is not recognized as an important issue. The lack of recognition that the absence of women in the sector is a problem, leads to an absence of data of the participation of women at each level of the career and position in the sector and along the years. In addition the hiring and promotion processes in these companies do not take gender into account.

In this context an important, although still introductory, initiative in Brazil is the MME's Permanent Committee on Gender, Race and Diversity Issues (Cogemmev). This committee is comprised of representatives from governmental bodies and public energy companies. The gender equality programmes in public companies are aligned with the Gender and Race Pro-Equity Programme, an initiative of the Federal Government (PNPM – "*Política Nacional para Mulheres*") with the partnership of UN Women and the International Labour Organization (ILO). Although it is still limited to communication activities (campaigns, workshops and lectures), the gender equality agenda from the energy public companies in Brazil has been making some progress. Some important initiatives have emerged which are more focused on targets and less on "quotas", such as the recent announcement from Petrobras to increase to 40% women participation in decision-making positions (from the current 18% to 25% by 2025), under a meritocratic approach. However, since these policies are not transversally implemented and are not monitored by an external organization, they might not survive in time.

In addition to following the percentage of women in the leadership of energy sector, the impact of it on the women in population in general is also relevant. On the social side, the report assessed two important governmental programmes: a) "*Luz para Todos*" (Light for All), which boosted household energy access; and b) "*Minha Casa Minha Vida*" (My House, My Life), which demonstrated the potential use of solar panel in social housing programmes. Both programmes economically empowered women, whilst also improving their quality of life and offering better access to income generation. However, these programmes did not provided capacity building for technology management to women, which could help eliminate stereotypes that put women away from the energy area. The implementation of capacity building initiatives should be preferably led by female engineers in order to help empower women at community level without reinforcing the historical privileges of men over women.

With regard to social projects in the energy sector involving low-income communities, isolated areas, and rural areas, although there are some initiatives in Brazil, most stakeholders are not aware of them. These projects tend to be small scaled or pilot projects with no sustainability analysis or strategy for results dissemination and replicability.

Overcoming barriers for gender issues in the Energy sector requires not only recognition of the baseline or the current situation in the country, but also a good monitoring of indicators, in order to identify the problem and to support public policies and companies or NGOs' project management. Both quantitative and qualitative indicators are relevant to appraise the level of success and efforts allocation. This report also suggests actions, indicators and recommendations for gender equality in the energy sector in Brazil.

Chapter 6: Recommendations

Based on the current assessment of energy & gender in Brazil, the interviews involved, as well as the actions and indicators provided in this project, we suggest the following recommendations to increase women's participation in this sector, which may be supported by the British Embassy Brasilia via the UK Prosperity Fund's Energy Programme. Our recommendations are to:

- Promote and encourage companies to have continuous internal management systems and policies for gender equality.
- Include diversity and social inclusion questions or requirements in the implementation of projects at ANEEL and ANP aimed at using the so-called 1% levy for R&D in the energy sector.
- Women should be involved in social programmes promoted by the energy sector not only as the recipient of the support but also as the technical people involved in the programme.
- Support existing legal frameworks on gender equality, such as the COGEMMEV initiative at the Brazilian Ministry of Mines and Energy (MME), including data monitoring schemes. Collaborations with COGEMMEV could be stablished contacting its responsible staff at the MME. This could facilitate the identification of common interests and ways to collaborate.
- Build a network of women in energy by carrying out a series of workshops across the country on gender equality in the energy sector, preferably alternating the location of its editions across different regions of Brazil.
- Implement a capacity-building programme for women's technical training in energy subjects. This could be done, for example, in collaboration with existing programmes at the National Service for Industrial Training (SENAI), which are not yet specifically geared towards women.
- Offer dedicated scholarships for women in energy. This could be done in partnership with the British Council and/or the Research Councils of the UK Research and Innovation[45]. This initiative could also enhance collaborations between Brazil and UK in the energy area.
- If the UK Government decides to support the creation of a Brazil-UK Energy Centre, as described in the report recently commissioned by the British Embassy Brasilia (see more in Strapasson *et al.*, 2019), this centre could also have activities on energy & gender, and build a large database in this area, available in public domain. This database could not only compile existing data from several agencies and companies, but also offer original data by carrying out periodic surveys and assessments with the energy sector. The Energy Centre should also promote workshops about women empowerment.

[45] The UK Research and Innovation is comprised of the following councils: Arts and Humanities Research Council; Biotechnology and Biological Sciences Research Council; Engineering and Physical Sciences Research Council; Economic and Social Research Council; Innovate UK; Medical Research Council; Natural Environment Research Council; Research England; and Science and Technology Facilities Council. See more at: https://www.ukri.org/

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Table 5: List of participants

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5	**Beatriz Helena Matté Gregory**	Agência Nacional de Energia Elétrica (ANEEL) e Comitê Permanente para Questões de Gênero, Raça e Diversidade do Ministério de Minas e Energia e Entidades Vinculadas (COGEMMEV).
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7	**Clara Barufi**	Comunicação de empresas do setor de energia
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9	**Danielle Simões Guimarães**	Ministério de Minas e Energia (MME)
10	**Elbia Gannoum**	Associação Brasileira de Energia Eólica (ABEEOLICA)
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22	**Nilton Cesar dos Santos**	Eletrobras
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24	**Renata Isfer**	Ministério de Minas e Energia (MME)
25	**Silvia Andrea Cupertino**	Coordenação de Estatais do Distrito Federal
26	**Simone Pereira de Souza**	Núcleo Interdisciplinar de Planejamento Energético (NIPE) da Universidade Estadual de Campinas (UNICAMP)
27	**Solange David**	Câmara de Comercialização de Energia Elétrica (CCEE)
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APPENDIX 1 – UN SDGs and the Gender Gap

United Nations' Sustainable Development Goals (SDGs) and the Gender Gap

According to the United Nations, "the Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all" (UN, 2018), as the SDGs address the global challenges faced by human being (poverty, gender equality, all types of inequality, climate, environmental degradation, prosperity, and peace and justice). The energy & gender issue is recognised as a key driver for economic growth and development. Based on this, in 2017, the European Union launched a public call for tenders in order to promote a new initiative named "Women & Sustainable Energy" with €20 million available to implement activities promoting women entrepreneurship in the sustainable energy sector in developing countries (European Commission, 2018).

Our study is related to SDGs 5 and 7, and intersecting with issues related to SDG 13. SDG 5 states the importance of achieving gender equality and empower all women and girls. Bina Agarwal (2018), a professor at the University of Manchester, during her speech on Gender equality and food security, stated the importance of SDG 5 as a tool to potential access to and control over land, access to financial services, access to natural resources and effective participation in public life. Bina Agarwal concludes that it is necessary to interpret SDG 5 broadly and imaginatively intersecting with other relevant SDGs concerned with gender equity: SDG 1 (no poverty), SDG 2 (zero hunger) and SDG 6 (drinking water). Effectively interpret SDGs that deal with gender indirectly: SDG 13 (climate action) which involves gender too. In addition, we must address considerations on gender equality and SDG 7 that states to ensure access to affordable, reliable, sustainable and modern energy as the goals are interconnected, and become clearer that it is important to achieve gender equality in order to achieve these goals.

APPENDIX 2 - Overview on the Brazilian energy sector

The Brazilian energy mix and the role of renewable energies

Brazil is the largest energy market in Latin America and the 7th largest energy supplier in the world, with nearly 2% of the world's energy supply (Table 6).

Table 6: Top ten energy suppliers in the world.

	Country	Total primary energy supply (Mtoe)	Share in the world TEPS 1971	2016
1	People's Rep. of China	2958	7,0%	22,0%
2	United States	2167	29,0%	16,0%
3	India	862	3,0%	6,0%
4	Russian Federation	732	N/A	5,0%
5	Japan	426	5,0%	3,0%
6	Germany	310	6,0%	2,0%
7	Brazil	285	1,0%	2,0%
8	Korea	282	0,3%	2,0%
9	Canada	280	3,0%	2,0%
10	Islamic Republic of Iran	248	3,0%	2,0%
	Rest of the world	5211	44,0%	38,0%
	World	**13761**	**100,0%**	**100,0%**

Source: IEA World Energy Balance (2018).

In 2017, Oil and Gas accounted for around 50% of the energy supply in the country (Figure 11). From 2008 to 2017, the share of Natural Gas participation increased from 10.3% (2008) to 13% (2017) with expectations of a growth pattern. Renewable energy is extensively used in the country with 42.9% participation in the energy matrix in 2017. According to the International Energy Agency's report (IEA, 2018), Brazil has the greenest energy mix amongst the world's largest energy consumers. Sugarcane-based energy (including ethanol fuel for transport, and bioelectricity with sugarcane bagasse) accounts for 17% of the energy matrix, making it the second most important in the total energy supply, only after petroleum. Brazil's use of renewable energies is much above the world's average.

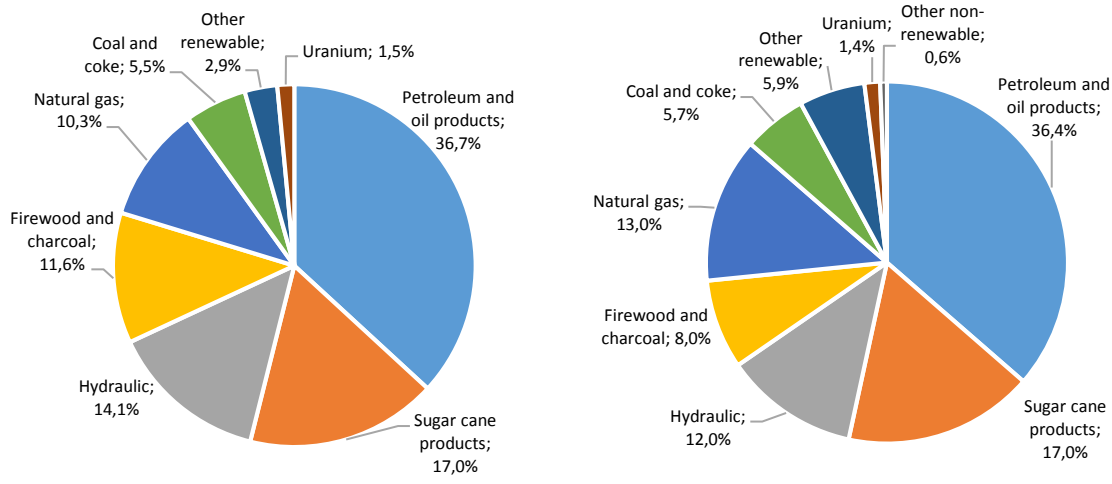

Figure 11: Brazilian Domestic Energy Supply in 2008 and 2017, in percentage of primary energy

Source: Prepared by the authors, based on the Balanço Energético Nacional (EPE, 2018)

The IEA forecasts a significant increase in renewable energies worldwide in order to meet the global energy demand and make a transition towards a low carbon economy (IEA, 2018). Numbers presented by the agency suggests an increase by one-fifth in the next five years to reach 12.4% in 2023. In Brazil, the forecast is to reach a share of 45% in renewables of total final energy consumption in 2023. In the last ten years, there were some changes in the participation of renewables in the Brazilian energy mix. While new renewables, such as wind and solar, increased its participation (from 2,9% to 5,9%) the most traditional source – hydraulic, decreased from 14,1% to 12% (as shown in Figure 1), although their installed capacity also increased.

Projections for 2026 include a further increase in "other renewables" (wind and solar) participation in the Brazilian energy mix, from the current 5,9% to 8% (EPE, 2018). High costs of wind and solar were considered a barrier for further development of new renewables a few years ago, but the global market has accelerated the cost reduction. According to IRENA (2018), in its "Renewable Power Generation Costs" report, electricity costs for renewable power has continued to fall, making it gradually competitive. In 2017, onshore wind average price was USD 0.06/kWh, while for new hydropower projects it was USD 0.05/kWh. Solar photovoltaic (PV) electricity costs have been falling significantly since 2010, with new projects commissioned in 2017 (73% decrease between 2010 and 2017) at USD 0.10/kWh. Technology improvement was one of the key drivers for the cost reductions of the new renewables and remains a priority on the transition for a low carbon economy.

Recent energy auctions in Brazil (and other countries such as Canada, Germany, India and Mexico) resulted in onshore wind power costs as low as USD 0.03/kWh, making the source one of the most competitive sources of new generation capacity. It is envisaged that electricity from renewables will soon be consistently cheaper than from most fossil fuel options. Projections to solar PV costs indicate that they can go down to about USD 0.06/kWh in terms of global average prices by 2020 (IRENA, 2018).

IEA estimates that by 2023 wind energy will remain in second place when it comes to growth capacity in the renewable field, expected to expand 60%. Hydropower tends to remain in first place as the main renewable electricity source. Solar photovoltaic is expected to keep increasing and should lead the expansion of installed capacity for renewable electricity. Data show renewable capacity adds around 178 gigawatts (GW) in 2017, with the great expansion in solar PV capacity (around 97 GW - half of which in China) (IEA, 2018).

The power sector and low carbon transitions

The Brazilian power generation has around 65% of hydropower (EPE, 2018), as shown in Figure 12, and it is likely to maintain this status. In 2017, the share of renewables in the energy mix was one of the highest in the world. In terms of primary energy, the main source of renewables in the Brazilian energy mix is sugarcane followed by hydropower (as previously shown in Figure 11), which currently dominates the electricity sector. However, large hydropower projects have reached its limits due to social and environmental constraints, which may lead to structural changes in the sector in medium and long terms, with further increase in wind power, solar PV and biomass, as well as non-renewable sources, particularly natural gas and, potentially, nuclear energy.

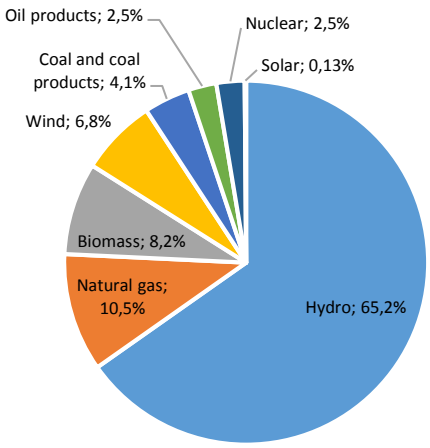

Figure 12: Brazilian domestic electricity supply in 2017

Source: Prepared by the authors, based on "Balanço Energético Nacional" (EPE, 2018).

Forecasts from the Brazilian Solar Power Association (Absolar) show a large increase in wind power and solar PV in the coming years. According to them, these sources currently correspond to around 8% and 1% respectively in the power mix (Soares, 2018). Brazil currently has a solar PV installed capacity of 1.6 GW. Projections from the Brazilian Energy Research Company (EPE, 2018) also suggest an increase in solar power, reaching a 10% share of the total electricity mix by 2030.

As the generation of electricity increases from wind and solar power sources, the systems will require more stability, mainly due to the intermittence from wind generation. Some experts argue for more gas thermopower, while others ask for the use of hydropower. However, due to uncertainties regarding the raining seasons, it is unlikely that hydropower will be enough to stabilize the system.

Most of the wind farms in Brazil are in the Northeast. The region is becoming more vulnerable over time in terms of grid stability, because of the intermittence of wind power generation. Thus, they depend on the energy generated and transmitted from the Southeast, which includes energy losses and costs associated with long transmission lines.

According to Absolar, solar PV has decreased in cost by 75% in the last decade and has become a competitive energy source. The increased price in energy tariffs in the past years has made this source competitive, when considered the potential return of investment, with potential reduction of power bill costs in 90% (Soares, 2018). The Association has also stated that with not much investment from the government the Solar PV sector presented one of the most effective costs reduction. In 2014, the government launched the first Auction at Federal Level, exclusive/dedicated for Solar PV, thus supporting the increase of this market (Evolverde, 2018b). Dedicated/exclusive auctions for wind started in 2009. This was an important initiative to support market development. In 2011 wind generation prices became competitive with other sources. The same is expected to happen with Solar PV in the short to mid-term.

Lower costs from Solar PV and wind and decreasing electricity costs from renewables as a whole will represent a significant energy policy change, bringing more competition from alternative power generation sources. While these sources are likely to provide very affordable electricity, with all the associated economic benefits, specialists argue that there is a need for a new model for the Brazilian

Power system to accommodate the increase in new renewables. For instance, the need for dispatchable energy, such as gas thermopower.

The Brazilian national integrated power grid has vast extensions across the country (Figure 13). The so-called National Interconnected System is managed by the ONS (National System Operator) which covers around 98% of Brazil's electricity transmission in the country. The system facilitates the transfer of electricity generation from one region to another, with exchange between all regions. The system is mainly based on hydropower. However, wind energy is growing in importance.

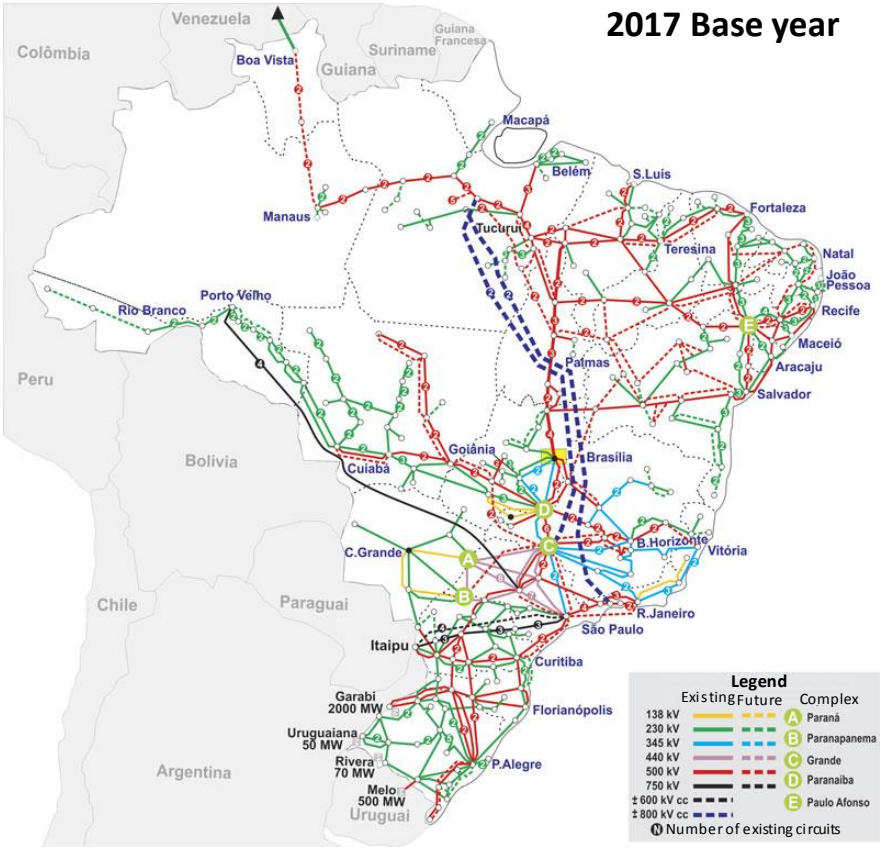

Figure 13: Brazilian integrated power grid.

Source: ANEEL. Figure translated by the authors.

To give a reference for the magnitude of this interconnected system, Figure 14 illustrates the size of the Brazilian interconnected transmission system compared with the Europe's map.

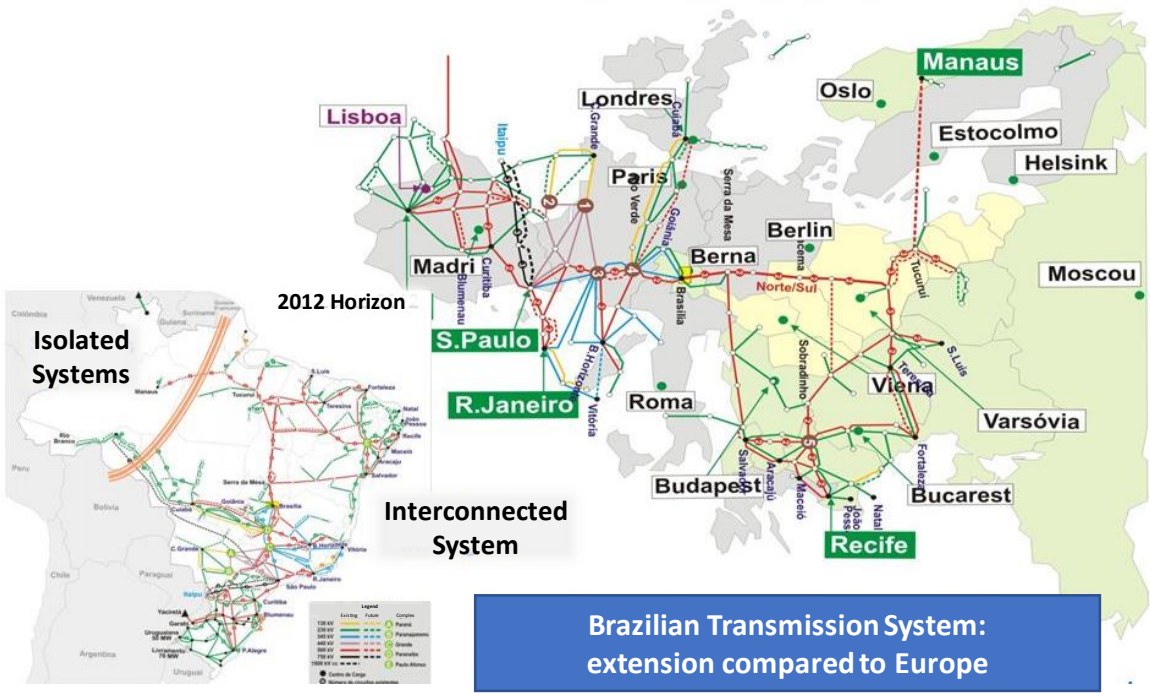

Figure 14: Comparative extension of the Brazilian power grid compared with the European scale.

Source: ANEEL. Figure translated by the authors.

Distributed Generation - challenges and opportunities:

Brazil has a history of relying largely on hydropower, with its entire system built around it. However, due to environmental concerns for new large hydropower and uncertainties regarding the raining season, the sector started to incentivise new renewables such as wind and solar.

Differently from wind power, which met great success in Brazil, distributed solar PV in mini and micro generation took some time to grow, mainly to the high costs of solar panels. In addition, little was done in terms of diffusion of those systems. However, things are about to change as solar photovoltaic (PV) technology has already achieved tariff parity with respect to the price of electricity charged by the distributors. More recently the numbers have increased and solar is expected to increase 122% by 2023 (Table 7).

Table 7: Expansion of electricity sources in terms of installed capacity.

Installed capacity, MW		Conservative scenario, MW					Variation (%)
Source	**2018***	**2019**	**2020**	**2021**	**2022**	**2023**	**2018-2023**
Hydropower	101.880	107769	108991	109023	109023	109023	7.0
Thermopower	27.307	27895	29410	30709	30759	30759	12,6
Biomass	14.526	14651	14823	14861	14871	14871	2,4
Small hydro	5.897	6187	6371	6412	6436	6436	9,2
PV	1.850	2738	2770	3614	4109	4109	122,1
Wind	14.588	16376	16434	16454	16454	16454	12.8
Total	166.046	175614	178798	181073	181651	181681	9.4

* Actual data, as in January 2018.

Source: ANEEL (2018).

On the Distribute Generation side, the number of micro and mini generation of energy reached more than 20 thousand systems connected into the Grid in Brazil, enough to power around 370 thousand houses (ANEEL, 2018). Solar PV represents the majority of these systems. The residential consumptions represent 58,7% of these connections, while retail represents 35,25%. Some specialists forecast that Brazil will reach 1 million Solar PV systems connected to the grid in 5 years (EPE, 2018).

Solar PV became more popular in Brazil in 2012, when ANEEL (Brazilian National Regulatory Agency for Electrical Energy) regulated (*Normativa no. 482*) for power trade between consumers and distribution companies. Thus, the energy generated and not used could be sent to the grid, measured in kWh, through the "PV on grid" system and thus receiving credits for that. This is called Energy Compensation System, and it can be used to complement the months when the production is lower than the amount of energy that is consumed (World Future Council, 2018). In addition, Cupertino *et al.* (2018) pointed out that another incentive measure is the tax exemption in the acquisition of modules and photovoltaic panels in the rates of ICMS (Tax on Circulation of Goods and Services), of state competence, and the IPI, which is a federal tax applied to all national and foreign industrialised products.

However, the current Brazilian legislation also has some barriers, such as lack of incentive for renewable energy and especially for home solar systems (The Guardian, 2016). The energy credit is only valid for 60 months, and after that this extra production is "given" to the company, according to normative resolution no. 482/2012 stablished by ANEEL (2019a). Another critical issue is the minimum fee (cost of availability), that is always charged even if the production is higher than the consumption, which is problematic for those dwellers that cannot afford to pay for the electrical bill (World Future Council, 2018). The necessary amount to invest in this new technology is also a major issue, since it is still expensive and is considered to be profitable only after 4 or 5 years of use (RevoluSolar, 2016).

In addition, Cupertino *et al.* (2018, p. 9) pointed out the following list of disadvantages: (i) Remuneration of the cost of DG's (distributed generation) interconnection to the network, which is initially the responsibility of the owner of DG; (ii) Possible tariff variation depending on the interconnection utilisation rate; (iii) Possible high amortisation time due to the PV system's cost; (iv) Variations in the energy production of the system, according to the energy source adopted; (v) The energy distribution company to which an independent producer will connect with can only be a carrier and not a purchaser of the energy that is delivered by that producer to a remote customer; (vi) Greater complexity in the planning and operation of the electrical system; (vii) Greater complexity in procedures and maintenance, including safety measures to be taken and coordination of activities; (viii) Possible decrease of the utilisation factor of the distribution companies' facilities, which tends to increase the average price of its supply; (ix) Remuneration for the investments of distribution companies, arising or affected by the interconnection.

ANEEL recently carried out a public hearing (Audiência Pública no. 001/2019) in order to assess the impact of a possible review of Resolution no. 482/2012 (earlier mentioned). This specific consultation aims to analyse alternatives for the electricity compensation system already in place. According ANEEL (2019a), studies indicate that maintaining the current rules indefinitely would lead to high costs for the other users of the electricity grid, who did not install their own generation. In this sense, it would be necessary to modify the rules after further consolidation of the distributed generation market. The alternative draft document proposed by ANEEL suggests that current

compensation system should be maintained until the micro and mini distributed generation installed at each electricity distributor reaches a certain level (according to ANEEL, this occurs when local micro mini distributed are consolidated with the installation of 3.365 GW nationwide). This includes both remote and local systems, when compensation occurs at the same address where the electricity is generated. ANEEL intends to open another public hearing in July 2019 in order to continue addressing the issue and, in this opportunity, there will be a draft resolution proposing changes for Resolution no. 482/2012).

Moreover, ANEEL has been assessing the viability of a "regulation by incentives" for the electricity distribution sector, whilst also evaluating the regulatory environment for the use of technologies in service improvement, energy efficiency and business development, including distributed generation (ANEEL, 2019b). In addition, Bill no. 2.932/2015, which is related to the National Plan for Smart Grids (PNREI – *Plano Nacional de Redes Elétricas Inteligentes*), aims to promote the dissemination of micro and mini generation of electricity, and it has goals to forecast regulatory, financial, credit and tax incentives. Also, it intends that projects implemented under its rules will be welcome, and will integrate the regulatory-remuneration base of the distribution companies, having the Energy Development Account (CDE) as a funding source. ANEEL has also been discussing with stakeholders from the energy sector about some potential regulatory adjustments, such as three components of energy tariff (Tariff for the Use of the Distribution System - TUSD level B; Other Components in R$/kW; and Energy Rate - TE in R$/MWh) or binomial rate in the distributed generation (ANEEL, 2019b).

Institutional organisation of the Brazilian electricity sector

The Brazilian electricity sector companies are classified by activities: generation, transmission, distribution, commercialisation, imports and exports. The sector is comprised of state-controlled and private companies (including private and public financing). There is competition in generation and commercialization, but transmission is considered a "natural monopoly". There are both "free" and "regulated" markets. In the free market, prices are freely negotiated for generation and commercialization, whereas in the regulated market auction and bids are set by the government for the lower cost offered by companies.

The sector is composed by the following Institutions:

- Ministry of Mines and Energy (MME) is responsible for energy policy formulation and implementation;
- National Energy Policy Council (CNPE), which is linked to the Brazil's Presidency, is responsible for advising the President in public policy formulation and strategies/guidelines for the sector;
- Energy Planning Company (EPE), linked to MME, is responsible for energy planning studies to subsidise the expansion of the electricity system, as well as other energy studies (e.g. oil & gas, coal, renewables and energy efficiency);
- Chamber of Electrical Energy Commercialization (CCEE), responsible for the negotiation of energy in the free market;
- Power Sector Monitoring Committee (CMSE) is responsible for monitoring and assessing both electricity supply and stability at national level;
- Brazilian Regulatory Agency for Electrical Energy (ANEEL);

- National Electric System Operator (ONS) is responsible for the coordination and supervision of the National Integrated System (SIN).

The ONS and CCEE are private, while the others are public. Figure 15 summarises the institutional organisation of the Brazilian electricity sector.

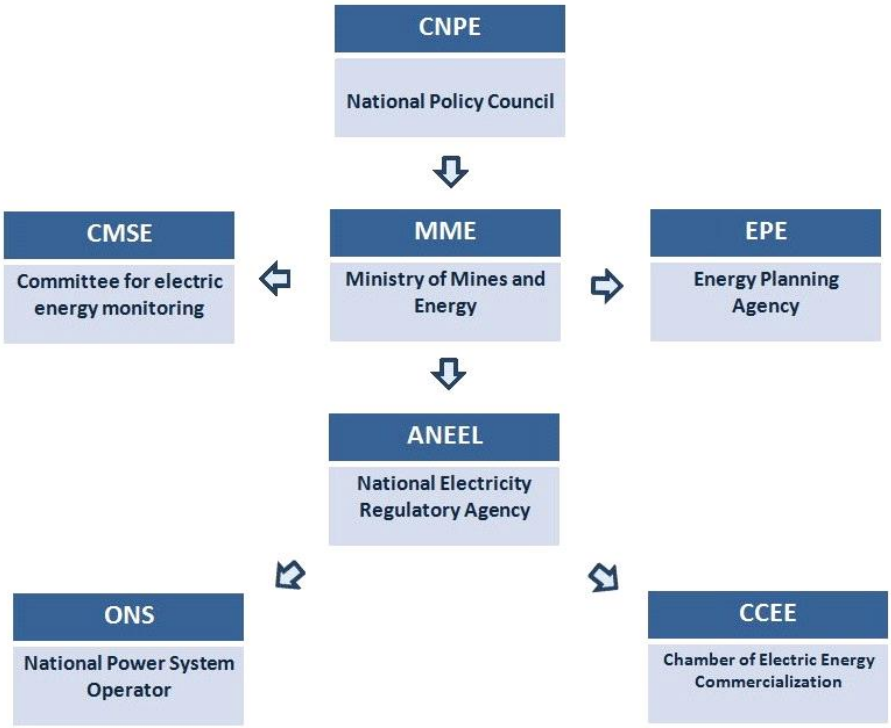

Figure 15: Official Brazilian electricity institutions at federal level.

Source: Prepared by the authors, based on the information from the Ministry of Mines and Energy.

Market and costs

Table 8 shows the average electricity costs by region in Brazil, which may vary substantially due to the vast dimensions of the Brazilian territory.

Table 8: Average electricity cost by region (R$/MWh).

Brazil's Region	2012	2013	2014	2015	2016	Δ% (2016/2015)	Δ% (2016/2012)
North	321.17	276.68	303.53	372.93	419.75	12.6	130.7
Northeast	297.09	250.52	269.05	340.00	367.64	8.1	123.7
Southeast	294.78	260.24	282.22	413.04	441.65	6.9	149.8
South	277.23	235.15	264.27	409.28	415.10	1.4	149.7
Midwest	290.41	257.74	273.63	398.07	419.38	5.4	144.4
Brazil Average	**292.85**	**254.45**	**276.97**	**395.00**	**419.09**	**6.1**	**143.1**

Source: Prepared by the authors, based on information from the National Electricity Regulatory Agency's System for Decision-making Support (SAD).

The transition to a low carbon economy is good news for gender equality, as it is a field in which multidisciplinary aspects become even more relevant and which involves environmental engineering which also has a larger percentage of female students. This suggests that if the gender equality policy would be in place, it would be easier to have more gender balance.

APPENDIX 3 – Additional figures

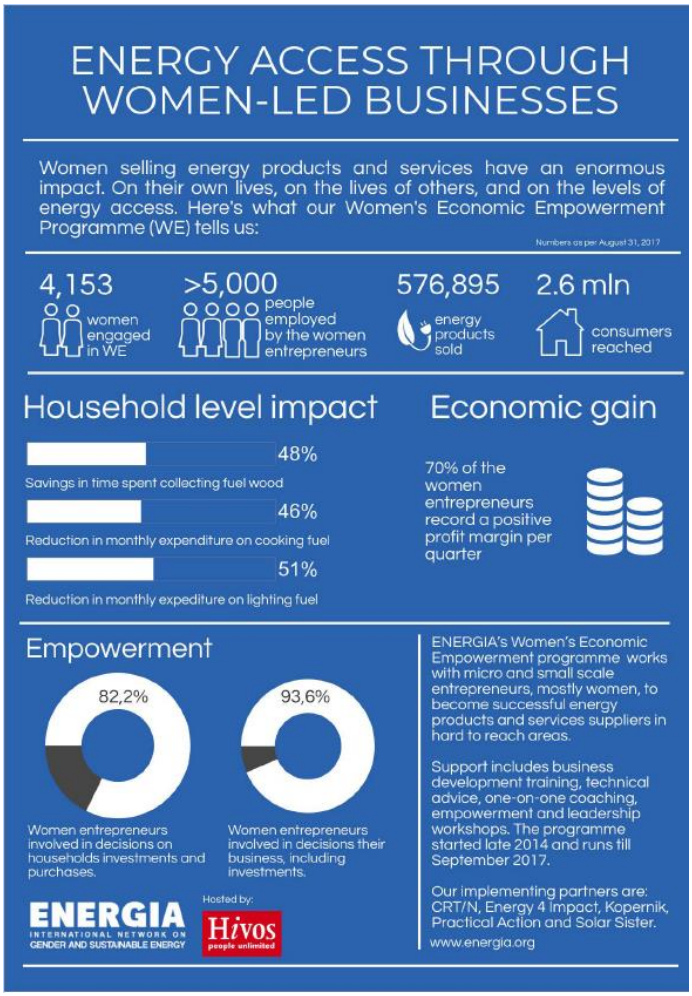

Figure A1: Women's Economic Empowerment

Source: Energia – International Network on Gender and Sustainable Energy

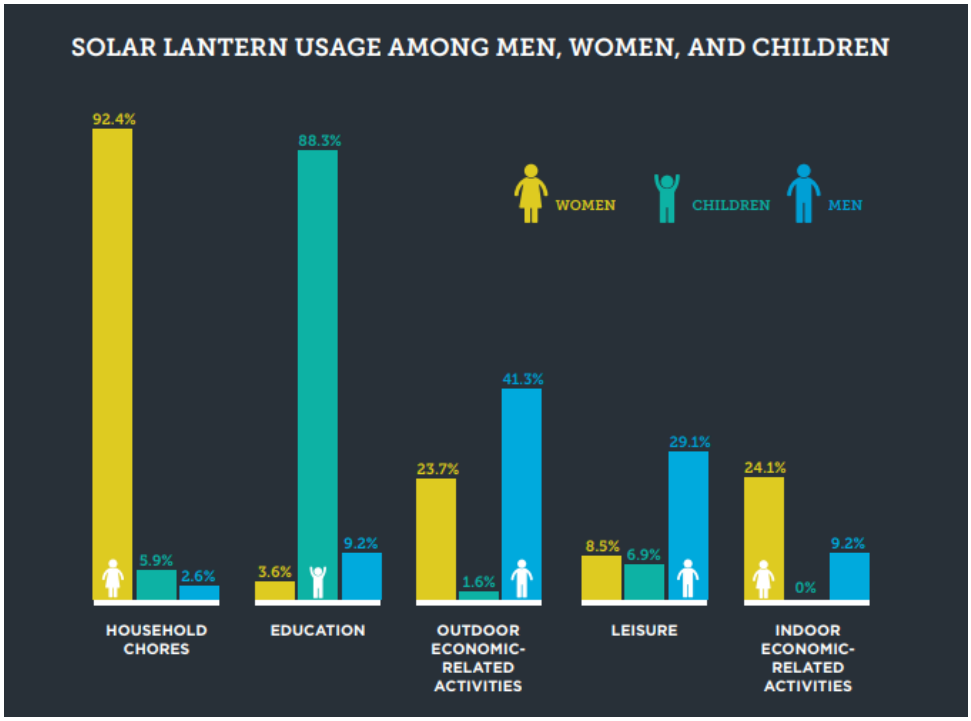

Figure A2: Solar Sisters Initiative.

Source: Miller Center for Social Entrepreneurship research.

APPENDIX 4 – Original questionnaire

Original questionnaire in Portuguese version:

O projeto “The Gender Equality in the Energy Sector in Brazil” é uma iniciativa da Embaixada Britânica no Brasil, com apoio do Prosperity Fund do Reino Unido. O projeto tem por objetivo conhecer as principais iniciativas de atuação de mulheres na área de energia no Brasil seja em projetos sociais, seja em posição de decisão em empresas de energia. Para isso, o projeto envolverá a realização de questionário com entidades selecionadas de maior relevância nacional. Esse questionário foi desenvolvido pela equipe do projeto, formada por consultores independentes, sob coordenação de Juliana Falcão e Alexandre Strapasson.

As informações e respostas ao questionário são sigilosas e as análises realizadas a partir de seus resultados guardarão o anonimato da fonte. Desde já agradecemos a sua colaboração!

Nome:

Função:

E-mail:

1 - Qual a sua percepção sobre a inserção das mulheres no setor de energia, desde a formação (nível graduação) até a ocupação de cargos de decisão? Existe algum acompanhamento com dados sobre estes avanços?

2 - Você tem acompanhado iniciativas de inserção profissional de mulheres no setor de energia? Se sim, quais?

3 - A instituição que você trabalha possui iniciativas sobre igualdade de gênero? Quais?

4 - Sua instituição atua em projetos sociais no setor de energia que envolvam comunidades de baixa renda, áreas isoladas, áreas rurais, ou congêneres? Esses projetos tentam envolver mulheres?

5- Como mulher atuante no setor, que sugestões você daria em termos de formação para que mais mulheres pudessem atuar e progredir na área?

6. Na sua opinião, como a Embaixada Britânica poderia contribuir em prol da igualdade de gênero no setor de energia no Brasil? Você teria alguma sugestão de iniciativa concreta?

7. Você teria algum outro comentário ou sugestão ao projeto, inclusive de estudos de caso para conhecimento e análise, seja no setor público ou privado?