

Fostering Women Entrepreneurship in Solar Sustainable Development

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ABSTRACT

This study examines the vital contribution of women's entrepreneurship in sustainable industries as a strategic avenue for economic empowerment and social progress. Despite the increasing scope for self-employment within green sectors, women's access remains restricted due to policy limitations and structural barriers. By promoting women's active engagement in green entrepreneurship, this approach not only enhances their financial independence and social standing but also supports environmental sustainability and aligns with national economic development goals. The study provides an overview of how entrepreneurial opportunities in environmentally sustainable sectors can be leveraged to foster inclusive economic growth and long-term well-being for women, society, and the planet.

Keywords: Women's entrepreneurship; green economy; sustainable industries; economic empowerment; rooftop solar entrepreneurship, gender & development

INTRODUCTION

Building a green economy is a key priority for India to ensure both ecological balance and economic sustainability (Ministry, 2015). Expanding public awareness around employment and entrepreneurial opportunities in sustainable sectors is essential to boost citizen engagement. Women, who make up approximately 48% of India's population, can be pivotal in advancing the green economy through their active involvement (ILO, 2015). *"The importance of women's participation in climate change and bringing sustainability has been recognized at the global level. The Conference of the Parties to the United Nations Framework Convention on Climate Change, at its eighteenth session, in 2012, adopted a decision to promote the goal of gender importance in climate change and delegations to the sessions of the Conference of the Parties as a standing item on the agenda of the Conference"* (UNWomen, 2014). Empowering women to achieve economic independence is essential for their personal development and for reducing financial dependency (World, 2015). Gaining financial freedom and contributing to household income enhances women's decision-making power within families. While self-employment opportunities in rapidly expanding sustainable sectors are available, it is primarily the responsibility of policymakers to ensure these opportunities are accessible through women-focused initiatives. By embracing these prospects, thousands of women across India can become self-reliant, improving both their financial and social standing. Promoting women's entrepreneurship in sustainable industries not only raises their standard of living but also contributes positively to environmental goals and broader sustainability (Bhardwaj, 2012). Greater participation of women is a key driver in achieving the nation's sustainable development targets (WHO, 2014).

This study seeks to explore ways of fostering entrepreneurial opportunities for women in green industries to encourage their active role in economic development, thereby advancing sustainable wellbeing for women, the environment, and the broader economy

Promoting Women Entrepreneurship

"As the 2012 World Development Report highlights, empowering women's potential workforce has significant economic benefits beyond promoting just gender equality" (WorldBank, 2012). In the past three to four decades, India has successfully fostered numerous women-led enterprises through small-scale industry programs, particularly in the food sector. A notable example of a successful women-led enterprise is Lijjat Papad (a rice crisp product), a cottage industry started by a group of rural women that grew into a multibillion-rupee business, now established in both national and international markets (Mahila Udyog, 2015). Various actors such as the central government, state governments, national banks, cooperative banks, NGOs, and some corporate companies promote women entrepreneurship through funding and Entrepreneur Development Programs (EDPs). These EDPs provide women with the necessary skills, knowledge, and financial support to start businesses, either individually or in groups. Nationalized banks like the State Bank of India (SBI) and the Small Industries Development Bank of India (SIDBI) periodically offer loans to support business development, with minimal interest rates under special loan schemes designed for women entrepreneurs (Economic, 2015).

Image # 1: India's state-wise women-owned small-scale enterprises**State-wise distribution of small scale industrial units owned by women entrepreneurs**

S.No.	State/Union Territory	No. of SSI Units	Percentage to Total
1	Kerala	139225	13.09
2	Tamil Nadu	129808	12.20
3	Karnataka	103169	9.70
4	Maharashtra	100670	9.46
5	Andhra Pradesh	77166	7.25
6	Uttar Pradesh	72667	6.83
7	West Bengal	69625	6.55
8	Madhya Pradesh	68823	6.47
9	Gujarat	53703	5.05
10	Bihar	49443	4.65
11	Orissa	38233	3.59
12	Rajasthan	36371	3.42
13	Punjab	29068	2.73
14	Delhi	14383	1.35
15	Assam	11757	1.11
16	Manipur	10745	1.01
17	Chhattisgarh	10034	0.94
18	Haryana	9620	0.90
19	Uttaranchal	8804	0.83
20	Jharkhand	7865	0.74

Source: http://smallb.sidbi.in/sites/default/files/knowledge_base/statewisedistributionofwomenentrepreneurs.**Image # 2: Small-scale industry units classifications:****Classification of SSI units in India on the basis of registration**

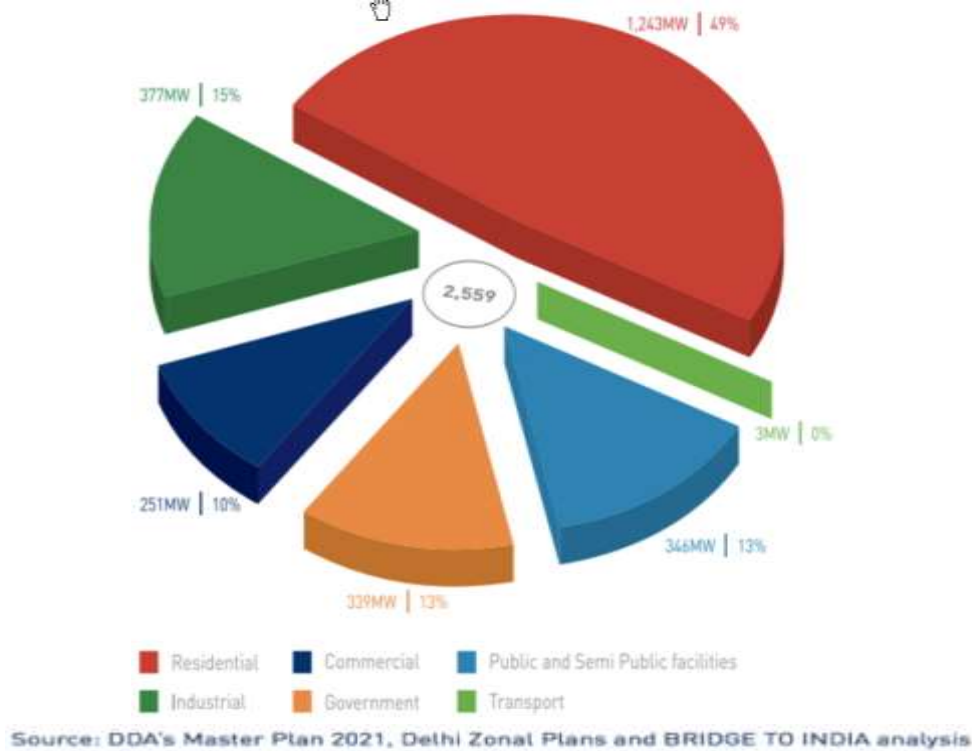
S.No.	Characteristic	Registered Units (In Lakhs)	Unregistered Units (In Lakhs)	Total
1.	Men	12.37 (13.08)	82.20 (86.92)	94.57 (100)
2.	Women	1.38 (12.93)	9.26 (87.07)	10.64
	Total	13.75 (13.07)	9.26 (86.93)	105.21 (100)

Image source:

http://smallb.sidbi.in/sites/default/files/knowledge_base/statewisedistributionofwomenentrepreneurs.**Solar renewable energy demand and business essentials****Market Potential:**

India has abundant natural sunlight, illuminating nearly every household and offering vast potential for harnessing renewable energy through solar technologies (Sudhaman, 2015). Well-designed solar energy policies that balance environmental, economic, and social benefits can significantly contribute to the nation's sustainable development goals. Over the next decade, India's solar market is projected to generate billions in business, with forecasts estimating over \$8 billion in solar equipment sales and more than \$5 billion in revenue from grid-connected solar systems.

Image # 3: Rooftop Residential Solar Power Generation Potential Delhi



According to the data, Delhi's residential sector alone has the potential to produce 49% of its energy through residential rooftop solar systems. Whereas other sectors like Industries, factories, and commercials can contribute 15% in each segment (Greenpeace, 2013).

Image # 4

Below indicators explain the future high demand for skilled employment in rooftop solar energy in India (NRDC, 2015).

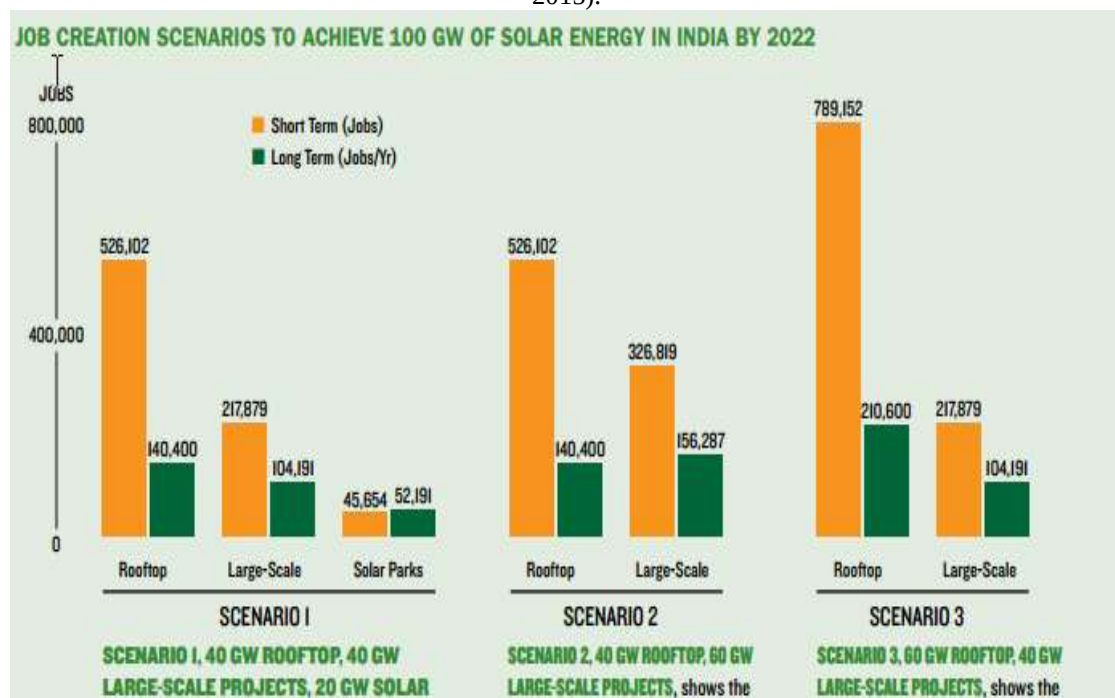


Image source: <http://www.nrdc.org/international/india/files/india-renewable-energy-jobs-IR.pdf>

Image # 5: Solar meeting up the Demand and Supply gap

Solar can fill India's supply gap while tackling unmet demand

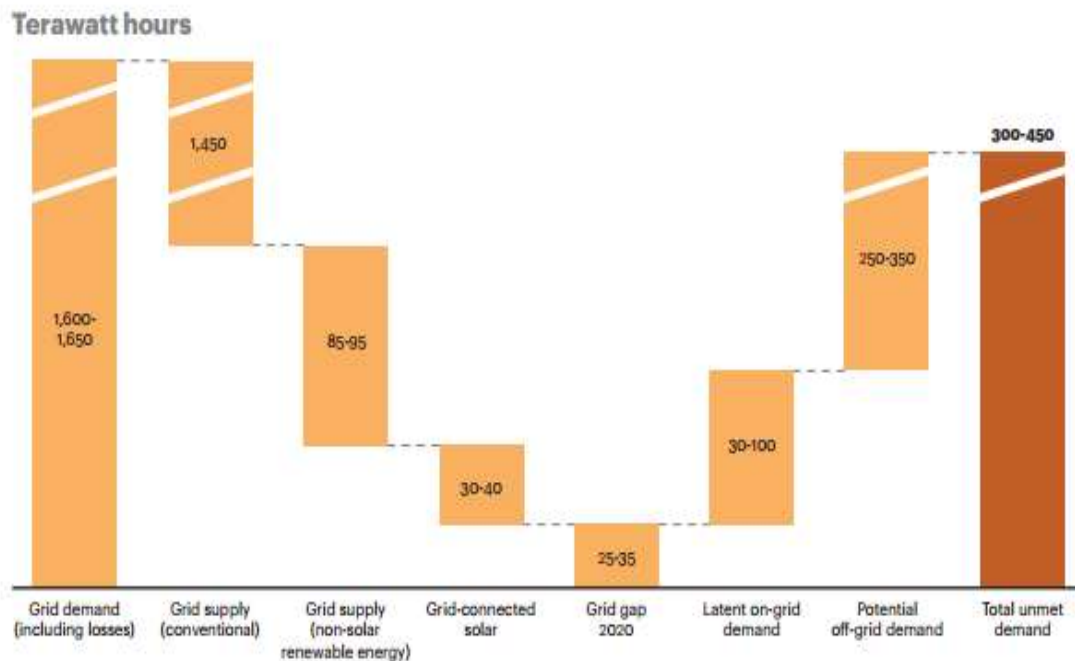


Image Source: ATKEARNEY/solar power and India's energy future

Image # 6: Solar Growth Phase and lowered production cost

Solar production costs will drop 20-25 percent in the seed phase and 15-20 percent in the growth phase

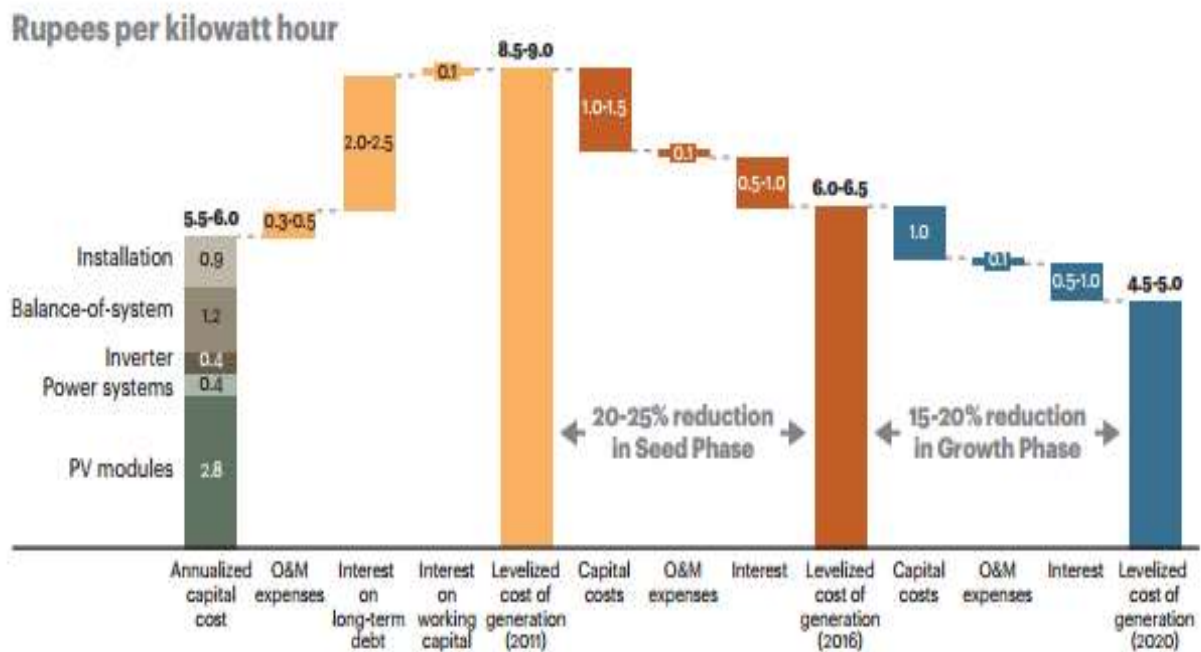
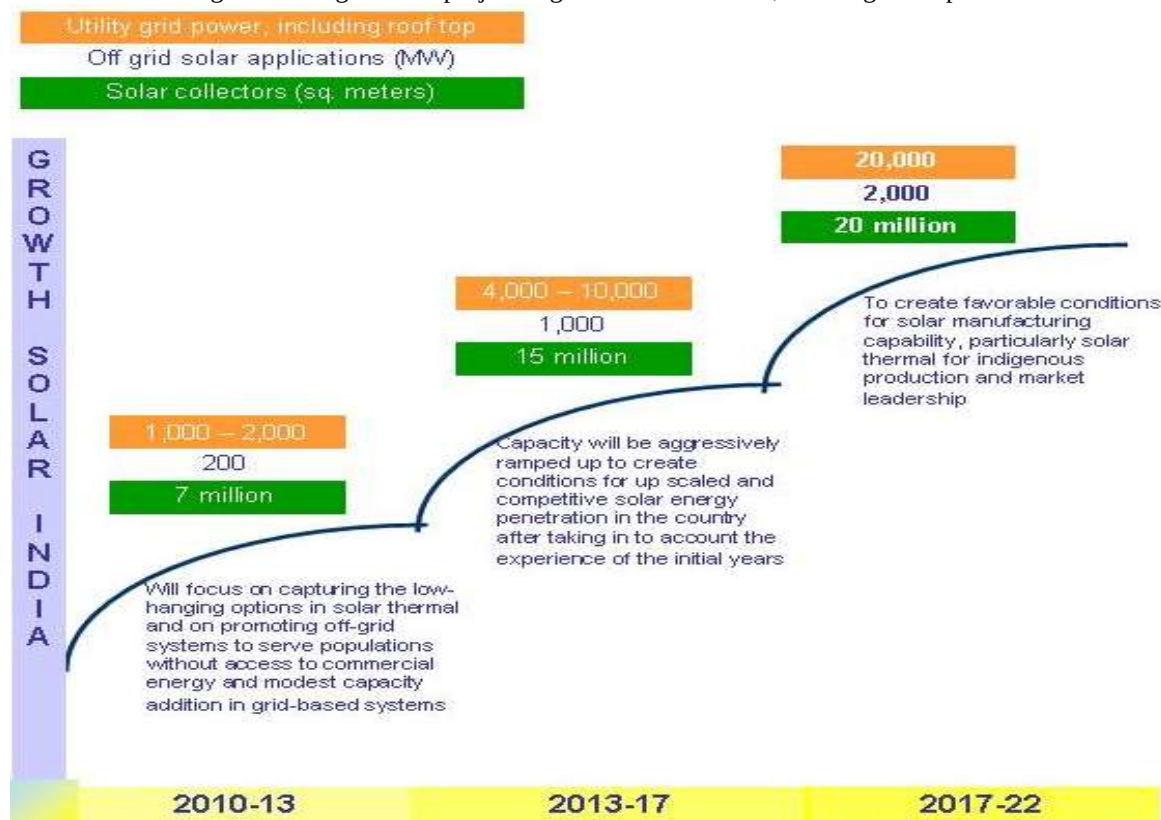


Image Source: ATKEARNEY/solar power and India's energy future

Image # 7: Off-grid solar projected growth 2010 to 2022, showing a sharp hike



LITERATURE REVIEW

“Sources, Agency, Achievements: Reflects on the measurement of women’s empowerment” (Kabeer, 1999).

About Naila Kabeer, the Author of the above literature: Naila Kabeer is the senior researcher at the Institute of Development Studies (IDS), University of Sussex, Falmer, Brighton, UK. She is a Socio Economist with research interests in gender, women’s empowerment, household economics, poverty, and population. She is a methodological developer also working for the US’s Division for the Advancement of Women. The literature emphasizes on empowering women who the author calls as: “*Women empowerment is the process to induce power to dis-empowered people*”. Power gives ability to choose what they want. An empowered woman will have skills to modify her choice to trial and perform outcome. Empowerment occurs slowly and formulates women to control resources and make strategic plans. The first step of empowering women is to make her choose confidently what she wants to choose. The ‘Choice’ is the first step, and it is important to bring quality and change for progress in life. The author talks about the following three dimensions of empowerment, which empower women to make the right choice, as explained below:

1. Resources: A condition of choice
2. Agency: A catalyst for choice
3. Achievement: Consequences of choice

The choice, agency, and achievements are interactive. They reflect social and institutional relationships. It’s a responsibility of social institutions to produce gender equality and promote the well-being of women. Empowerment can bring access to: Resources, Control over resources, and Utility of resources. Through empowerment, women will be able to identify the resources in their surroundings and utilize them to the maximum productivity for community well-being. While empowerment drives to shape up social values and inequalities in society, the achievement is the result of one’s capabilities. The differences in achievements are mainly due to the challenge, preferences, and characteristics of the individual. Kabeer’s literature is thus supporting this study of women empowerment in green sustainable economy by identifying the resources that can be related to the resource ‘renewable energy’, skills, and tools are delivered by different actors like governments, banks, and policy makers. The agencies, like NGO’s, training centers, would help women to identify the potential resources and make the right choice. The challenges and outcomes would result from her contribution to the sustainable environment and economic development.

“There is a clear need to provide more and better information about entrepreneurship as an attractive career option, for young women outside the labor force who are considering starting or getting back into work. Policies for female-owned enterprises should not exclusively target start-ups and small enterprises but include instruments to stimulate high-growth firms as well as growth and development in medium-sized and larger businesses. Sometimes, such policies could be focused on a particular sector” (Willem et.al., 2014).

Authors: Willem Adema, Nabil Ali, Valeri Fraey, Hyunsook Kim, and Monika Queisser. Background study: “Women’s Economic empowerment through entrepreneurship, new urbanization”. The author aims to focus on women who wish to return to the labor market or pursue self-employment. Skills are the most important tools in the labor force, and women must be equipped with the necessary skills to become a part of it. As highlighted in this study, solar energy is a well-developed and skill-intensive field that requires women to be adequately trained to handle the demands of the work and uphold the standards of the technology. With focused training, these skills can be successfully acquired. The governments need to initiate the process of providing such tools for women. The author is also talking about focusing on the individual segment for successful results. The solar projects can be identified as individual segments as trial projects for women, and the policies to drive women to enter entrepreneurship.

Entrepreneurship opportunities for women in the solar industry

The expanding green energy sector is opening up new avenues for employment and entrepreneurship among women (Bhardwaj, 2012). For many women who are unable to engage in full-time jobs or manage large enterprises due to family responsibilities, micro-entrepreneurship presents a feasible alternative, allowing them to work from home in their available time. In the solar small-scale industry, there is growing demand for marketing and servicing eco-friendly products such as solar lanterns, cookstoves, and heating devices (PV, 2014). These products not only help address power shortages but also provide sustainable alternatives to traditional fossil fuel-based cooking and heating methods.

List of current SME business opportunities associated with the solar industry.

Solar rooftop projects	Rooftop power generation and distribution
Be a service provider	Technical services and supervision of installed rooftop and other solar products
Sales of solar products	Solar PV, solar lights, solar fans, thermal systems, cooling systems, solar recharges
Distributorship	All solar technology, products, and consumables also including solar streetlights and backup generators
Project developer	Become a solar developer, be a consultant, or help in raising funds. This can be teamwork or individual capacities
Sales of the aftermarket product	Solar consumables for consumers who have already installed solar products: cleaning products, reagents, and sub-products
Third-party services	solar insurance, solar finance
Be an inventor	Acquiring solar projects by investing
Education service	Research to make the existing products better, solar product training classes, technical teaching, promotion of books
Be a landlord	Rent own properties/rooftops for solar panel installations

Image # 9: Estimated India market penetration, solar home light system

Estimation of the market penetration of solar home lighting systems in India:

	1997-02	2002-07	2007-10	Total
Total no. of SHS sold / distributed in India	262,857	471,429	approx. 300,000-400,000[ii]	approx. 1 – 1.2 million

Estimation of the market penetration of solar lanterns in India:

	1997-02	2002-07	2007-10	Total
Total no. of solar lanterns sold / distributed in India	490,000	526,500	approx. 1.2 – 2. million	approx. 2.3 – 3.2 million

Source: International Finance Corporation

Image source: <http://loopsolar.com/learning-center/> International Finance Corporation

Roof-top solar solutions and industry growth

The rooftop solar market has shown tremendous growth over the past two years. As of 31 March 2016, the growth rate was recorded at 90% compared to the previous two years. A total capacity of 740 MW has been installed, with the primary reason for this growth attributed to the competitive pricing of rooftop solar installations compared to grid power (Greenpeace, 2013). The commercial and industrial (C&I) market holds a 73% share, while the residential segment accounts for only 27%. By 2020, the industrial segment was expected to grow by 248%, and the residential sector by 200% (Energy, 2014). Many firms and investors have already captured rooftop markets in regions such as Delhi and Gujarat. At the same time, there are numerous successful and inspiring stories of women who have embraced the challenge

and led green businesses in India to great success. These women have not only gained financial benefits but have also made significant contributions to environmental sustainability. Some of these cases are discussed below in the case study. Image # 10:

Indicators showing the growth of small-scale sectors in India

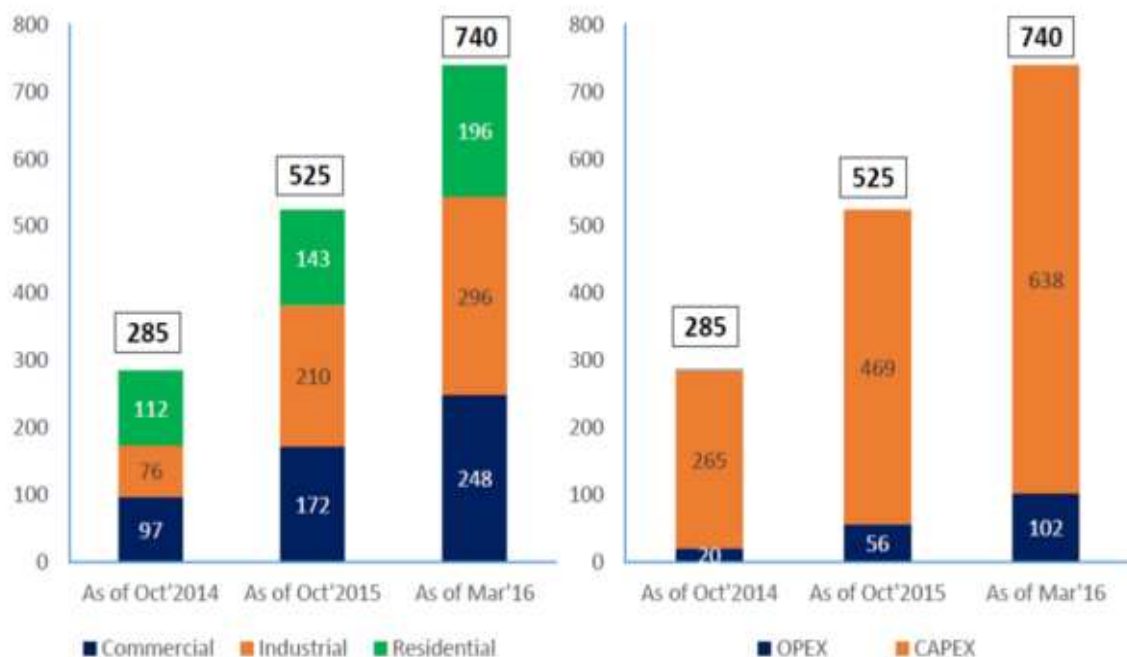


Image source: <http://www.yourarticlelibrary.com/industries/present-position-and-growth-of-small-scale-sector-in-india>

Micro business opportunities

Solar-powered services can enable many women to establish cottage industries such as home-based vegetable farming, animal husbandry, and egg incubation and supply using solar-powered units (Sunbest, 2015). These cottage business initiatives offer an excellent source of income for women who prefer agriculture and farming, as their products are in high market demand. The opportunities in the solar energy sector are diverse. Becoming a solar energy entrepreneur does not require building expensive solar parks; rather, a small area and a modest budget can be effectively utilized to generate, store, and distribute electricity (Booz, 2012). Women can also opt for freelancing services such as the installation and maintenance of solar panels and related products. As the number of solar consumers grows due to increasing product popularity, it becomes essential to educate users on the proper use and maintenance of these products to ensure durability. Setting up a solution centre would not only assist solar consumers in resolving issues but also present a strong business opportunity. Such centres can provide customers with comprehensive information on how to use and care for solar products. Customer queries can be addressed at these centres for a nominal fee. Establishing a consultation centre, with prior training in product handling, installation, and technical knowledge, offers a viable self-employment opportunity for women seeking low-investment ventures and who possess good communication skills. These centres can also serve to raise awareness about lifestyle changes, health, and sustainable environmental practices.

A Review of CDD Development

Community Driven Development (CDD) has a significant impact on women's empowerment, particularly in a country like India, which has a broad communal structure influenced by religion, caste, and gender, all of which shape the well-being and progress of communities. Several findings indicate strong support from the World Bank for countries that adopt the CDD approach. Accountability in traditional approaches and the impact of technical evaluations play vital roles in the successful implementation of CDD programs (ILO in India, 2014). Incentives and innovations can further encourage women's participation in CDD programs. For example, the recent introduction of an innovative solar cooking stove led to widespread adoption by rural women in the Indian state of Odisha, demonstrating the potential of CDD-driven initiatives. Designing a CDD program with problem evaluation, learning components, and clear development goals can lead to more effective outcomes. The primary aim of the CDD program is to increase the participation of vulnerable communities. In the context of this study, the focus is on the need for women's empowerment in sustainable development. The goal of CDD programs is to promote collective action that benefits a group of people (ILO in India, 2014).

Case Studies

a) Role Model Business - Rooftop Cities of Gujarat

Gujarat serves as a role model for other Indian states in rooftop solar projects and renewable energy production (MHummon, 2015). One key reason for Gujarat's success is the strong collaboration between the government and technical institutions, which together implemented numerous skill development training programs that created an employable workforce. The public-private partnership (PPP) programs proved to be the most successful, benefiting many previously unemployed youth (CERCCS, 2014). Participation in these programs not only enhanced their skills but also led to gainful employment. One such ongoing initiative is led by the private organization Azura Power, in collaboration with the Gujarat Energy Research and Management Institute (GERMI), a government body. Azura Power and GERMI aim to develop a skilled workforce capable of effectively installing rooftop solar systems. These organizations are working jointly to build a robust talent pool to help the Gujarat government achieve its ambitious target of 100 gigawatts of solar power by the end of 2022 (Power, 2015). An innovative initiative, the "Rent a Roof" concept, was developed in the city of Gandhinagar, Gujarat, through the Gujarat Solar Entrepreneurship Development Program. This project is now generating 5 MW of power, and its contribution to greenhouse gas reduction is estimated at 7 million metric tons (GEDA, 2015). The highly successful public-private rooftop project, supported by a team of skilled entrepreneurs, is now serving as a model for solar programs in other cities. This project not only provides household power solutions but also connects solar panels to the main power grid. This integration allows for significant benefits from the feed-in tariff system, offering a concession period of 25 years, generating both income and employment opportunities for decades (GEDA, 2015).

b) SEWA - Power of economic independence of Women: Social welfare by Informal sector women's association

When policymakers failed to meet the expectations of aspiring women entrepreneurs, a group of working women from the informal sector took the initiative to support women's entrepreneurship (Sinha, 2013). SEWA (Self-Employed Women's Association), an organization formed by women working in the informal sector, rose to the challenge and took on the responsibility of providing financial support to new women-led micro-businesses. SEWA addressed not only financial security, but also social concerns and the livelihoods of women. Its microfinance-plus services have supported more than half a million women across India, including those in green industries (World Bank, 2012). SEWA's efforts extended beyond financial assistance; it also raised awareness about the rights of women workers, household well-being, and contributed significantly to building women's self-confidence. The significance of mentioning SEWA in this study lies in demonstrating the transformative power of women's economic independence in driving social change. When a small group of economically independent women volunteers can organize efforts to improve the lives of other women and their communities, larger incubation centers have the potential to empower even more women and expand the scale of social and economic transformation.

c) Women lead Barefoot Solar Technology College

The Barefoot College concept has transformed the lives of many rural women for decades by providing education in solar technology (Nanieratisfrand, 2015). Located in a small district in western Rajasthan, Barefoot College aims to educate women regardless of their prior qualifications or age. The college teaches solar technology and related subjects, including rooftop installation, maintenance, and handling of solar peripherals. The students here are women, including grandmothers. The college was established specifically for women from financially disadvantaged backgrounds, offering them an opportunity to develop skills in modern technologies. Barefoot College has also gained international recognition, and currently, students from countries such as Tanzania are undergoing training there (UN, 2014). Barefoot College was founded over thirty years ago by social entrepreneur Sanjit "Bunker" Roy (barefootorg, 2012), who took on the challenge of providing free technical education to women from families living in extreme poverty. Today, the institution is remarkably led by his daughter-in-law, Ms. Magan Karnwar, who also teaches solar engineering. In one of her interviews, she shared, *"I just wanted to do something more than cooking and producing babies. This college gave me a chance to find the purpose of my life"* (barefootorg, 2012). Barefoot College has become a powerful source of inspiration and motivation for rural women to embrace challenges and prepare themselves to participate in economic development. The solar technology education it offers also promotes environmental awareness among women and steers them toward sustainability. While many women students at Barefoot come from difficult personal circumstances, such as abusive husbands or overwhelming household responsibilities (Education, 2012), they graduate with the confidence to become independent and secure an income through the skills they acquire. Over 10,000 national and international women, including many from African countries, have graduated from the college, with many empowered here to bring solar power to their villages.

CONCLUSION

Empowering women can lead to sustainable change by enabling their active participation as vital adopters of green energy. The necessary tools include strong support and collaboration from policymakers to reassess existing energy plans and develop new policies specifically aimed at supporting women entrepreneurs, as outlined below:

- Key implementation of solar-based businesses, particularly as micro and home-based industries, to expand opportunities for women.

- Assessment of the gap between women and the solar sustainability sector, and the provision of targeted solutions through education, technology access, financial support, and awareness.
- Effective development of female-led enterprises with long-term sustainability.
- Focused development programs specifically tailored for women's groups.
- Advanced education and technical training for women in the renewable energy sector, backed by government-mandated policies.
- High-quality skills development training to ensure competency and confidence.
- Leadership development programs to empower women to lead community-driven initiatives.
- Comprehensive understanding of environmental and sustainability benefits, promoted through public campaigns and initiatives.
- Support and encouragement through counselling services, along with recognition of women's needs and aspirations, to inspire change both within the individual and the broader society.

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