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SCIENTIFIC PAPER

'Women Power' in Renewable Energy: The Role of Nested Institutions in Vocational Training of Solar Energy Entrepreneurs in India

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A B S T R A C T

Conventional myths such as the poor are misfit to manage smart technologies or that women-led rural enterprises generally fall through faster than men managed ones - have since been broken as evidenced by various empirical studies. However, the research on solar energy enterprises managed by women, particularly in rural or peri-urban areas, has remained largely elusive while the impact of such women-led entrepreneurial energy-based start-ups has significant personal, social and community level consequential impacts. A range of institutional arrangements that support these entrepreneurs starting from identifying, training to building and sustaining of such start-ups are explored and evaluated in this paper. This paper shows that not only do women collectively run these enterprises but they also successfully incubate others in the community. The context of solar energy in rural communities has become all the more important for both a practitioner as well as a theoretical understanding of women entrepreneurship. This research deploys a qualitative method approach that uses both primary and secondary data; this is then put through a lens of systematic thematic analysis for discussion. The work contributes to policy discussions as well as build an empirical knowledge of how

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women-led solar technology-based enterprises are built, managed, sustained and scaled in rural areas

KEY WORDS: *entrepreneurship, entrepreneurial mindset, solar energy technologies, gender, rural development, community development, renewables industry, India, Institutions, AIWC, entrepreneurial training, learning and education*

Introduction

The initiatives in South Asia to disseminate solar energy technology applications in poor rural households and also develop rural energy-based entrepreneurship have proven positively consequential in contributing to community development and rural development. The penetration of Renewable Energy Technologies (RETs, hereafter) - in the form of Solar Home Systems (SHS, hereafter), Solar lanterns, Solar headlamps, Solar Crop Dryers amongst several other types - in rural households and the use of these technologies to create micro-enterprises have been widely cited as successful cases of solar renewables transforming communities and wider society. In rural India, the importance of women, being the primary users of household energy for cooking and heating, in the context of energy have been widely recognised by prominent and effective renewable energy-based institutions like The Energy and Resources Institute (TERI), AIW C (All India Women's Association), SEWA (Self Employed Women's Association), TIDE (Technology Informatics Design Endeavour), & SELCO (Solar Electric light company of India) and many others. One of the core objectives of these institutions have been to involve more women and transform them into energy entrepreneurs. Households who receive the SHS use the technology to start micro-enterprises from home by making and selling different home-made handicraft goods e.g., jute and silk products (Mukhopadhyay, 2017).

Cases can be found across rural societies of south Asia where microfinance organisations would offer small credit to women entrepreneurs to start renewable-based enterprises in their community (e.g., *Gramin Bank* and BRAC in Bangladesh offering similar credit facilities). Empirical studies exhibit that these women are found to be marketing Photo-Voltaic (PV, hereafter) systems, co-farming with their household heads using solar irrigation pumps and solar crop dryers, and also operating/running solar mobile charging systems (Barua, 2007). Besides their entrepreneurial initiatives with solar energy technologies, the women entrepreneurs in rural societies are not only actively engaging in complex business decision making

processes but also making, servicing, marketing, installing and selling solar energy technologies. It is therefore important to understand the background enabling conditions of these entrepreneurs that creates this scenario – this is where the current literature remains elusive and this research paper positions itself to fill the knowledge gap.

All India Women's Conference (AIWC) in India started providing women with solar lanterns and solar charging stations in urban and peri-urban regions of the country. These women - in urban and rural areas - would charge their lanterns during the daytime, and then later in the evening, they would rent out the solar lanterns to street vendors (selling vegetables, flowers, fruits, and other perishable commodities) and also to households that do not have electricity or face long hours of a power cut. The AIWC has also successfully implemented initiatives in solar-powered water purifier systems where women would sell purified potable water to the locality at very nominal rates (AIWC, 2009). In many communities across India, these solar energy-based micro-enterprises also hired other people from the local community. This has encouraged and in fact, triggered local entrepreneurship and entrepreneurial mindset (especially women, who count for 36% of the same) (UNEP, 2011), rural women are assembling solar accessories in village-based technology centres, solar engineers are increasingly employed in designing SHS, working in battery factories, and other accessory related businesses.

Importantly, therefore, it becomes crucial to understand the 'packaging' of rural energy-based programmes. The references made to the solar energy technologies earlier and related enterprises speak of a combination of various entrepreneurial components such as capacity building, technology transfer, training, financing, costing, and marketing. It would be imperative that innovative credit system, appropriate product design, grassroots-based effective and efficient after-sales-service along with other consumer-friendly options play a colossal role in above-mentioned cases. In light of the theoretical content, practitioner terms in RETs, and conceptual references made in this study, some of the keywords - *solar energy entrepreneurs, institutions* and *institutional arrangements* - in particular, are explored in the literature in the following section.

Background

Institutions and Institutional Arrangements

The concept of an institution can be popularly perceived as "*enduring regularities of human action in. situations structured by rules, norms, and shared strategies, as well as by the physical world. The rules, norms and shared strategies and constituted and reconstituted by human interaction in frequently occurring or repetitive situations.*" (Crawford & Ostrom, 1995: 582). Institutional arrangements are the policies, systems, and processes that organisations use to legislate, plan and manage their activities efficiently and to effectively coordinate with others in order to fulfil their mandate (UNDP, 2000).

Institutional arrangements are interpreted as different (in)formal regimes and coalitions for collective action and inter-agent coordination, ranging from public-private cooperation and contracting schemes, organisational networking to policy arrangements (Geels, 2004; Klein & Teisman, 2000). They include both formal and informal arrangements, can range from local to the global level, and may give rise to compliance or resistance. Institutional arrangements, understood as the dynamic set of formal and informal regulations and networks, are shaped by economic exchange, socio-cultural norms and political regimes, and may provide welfare, identity, solidarity and sense of belonging (Knack & Keefer, 1997). When related to development, the challenge is to understand the correlation between weak, missing or perverse institutional arrangements and poverty, inequality and resource degradation (Rodrik, 2002; Knack & Keefer, 1995).

Institutional arrangements play a significant role in determining the efficacy of a given set of policy or technological intervention (North, 1990). At the same time, the institutional design is key to development as it determines whether an institution promotes socially productive ends that benefit all members of society or are redistribute and benefit a small segment of society at the expense of others (Firmin-Sellers, 1995: 204).

In the context of this research, *nested institution* is the concept that is of particular relevance. Ostrom (1990) suggests that 'multiple, nested institutions' matters because "*in many urban policy spheres private and social benefits are mixed together defying attempts at pure market or pure government classifications for the provision of services*". In other words, multiple institutions, 'appropriately nested' can correct either gross market or

state failure when single rather than multiple institutional provisions are applied (Pugh, 1996).

Entrepreneurship and Defining a Solar Energy Entrepreneur

The archetypical and for-profit entrepreneurs who have been widely defined and explored as someone who initiates, organises, manages and controls the affairs of a business unit. They can also be the organiser (Say, 1840), speculator (Marshall, 1961) and also an innovator (Schumpeter, 1934) and the concept of entrepreneurship is often invoked to explain aspects such as economic development (Schumpeter, 1939), firm organisation (Knight, 1921), market dynamics (Kirzner, 1973), and leadership (Witt, 1998a).

Social entrepreneurs, on the other hand, "*play the role of change agents in the social sector, by adopting a mission to create and sustain social value (not just private value), recognising the relentlessly pursuing new opportunities to serve that mission, engaging in a process of continuous innovation, adaptation, and learning, acting boldly without being limited by resources currently in hand, and exhibiting heightened accountability to the constituencies served and for the outcomes created*" (Dees, 1998:15). Sustainable Entrepreneurship or 'sustainopreneurship' is also very relevant in the context of this research, this is defined as "*the discovery and exploitation of economic opportunities through the generation of market disequilibria that initiate the transformation of a sector towards an environmentally and socially more sustainable state*" (Hockerts & Wustenhagen (2010: 82).

A Solar Energy Entrepreneur is "someone who would do one or a combination of the following - buy, rent, borrow, sell, maintain, service, manufacture or install - any or a mix of solar energy technologies for setting up one or more income-generating energy-based enterprise/s." (Mukhopadhyay, 2020). Examples of these technologies would include solar home lighting systems, solar lanterns, solar crop dryers, solar kilns, solar wax melters, solar cookers, solar lamps and headlamps, solar irrigation pumps, solar mobile phone chargers, solar vans, and short-haul transport mobility vans amongst many others. The applications and multi-faceted use of these technologies are visible in both rural and urban areas. However, a wide range of local-level applications is largely seen in rural areas where communities get involved in the process of use and expansion of these technologies by eventually perceiving that the solar energy technologies are not 'additives' or 'add-on' energy options but an 'asset' (Mukhopadhyay, 2020).

Methodology

An exploratory research strategy was adopted that used qualitative case study method using a systematic thematic analysis. This is in line with important recommendations in the literature (Dana & Dana, 2005, Dana & Dumez, 2015) pointing out the need for expanding research methodologies in the area of entrepreneurship beyond quantitative studies and thus embracing more inductive and holistic perspectives. Braun and Clarke (2006:79) views thematic analysis as a method used for '*identifying, analysing, and reporting patterns (themes) within the data'*. Generally, thematic analysis is the most widely used qualitative approach to analysing interviews. Thematic analysis involves the identification of themes through '*careful reading and re-reading the data'* (Rice & Ezzy, 1999: 258). It is a form of pattern recognition within the data, where emerging themes become the categories for analysis. This approach complemented the research questions by facilitating an investigation of the interview data from both data-driven and research question perspectives, to check whether the data remained consistent with the research questions and providing sufficient information (Crabtree & Miller, 1999).

Codes and Themes

The coding process involved recognising an important moment and encoding prior to a process of interpretation (Boyatzis, 1998). Encoding the information organises the data to identify and develop themes from them. Boyaztis (1998:1) defined a theme as '*a pattern in the information that at minimum describes and organises the possible observations and at maximum interprets aspects of the phenomenon*'. Coding is the process of organising and sorting data since it serves as a way to label, compile and organize data. In linking data collection and interpreting the data, coding becomes the basis for developing the analysis. The questions employed in the interviews were open-ended to begin with, followed by semi- structured questions keeping the key points relevant to the research questions and respondents' posts and positions. The main categories and codes were identified from the data by observing patterns in responses from different interviewee groups.

The fieldwork took place in New Delhi and the state of Karnataka in India. Interviews were held in AIWC offices in both New Delhi and Bangalore city in India. It included senior management Staffs and project managers, in addition to project level-staff members, a total of 18 women

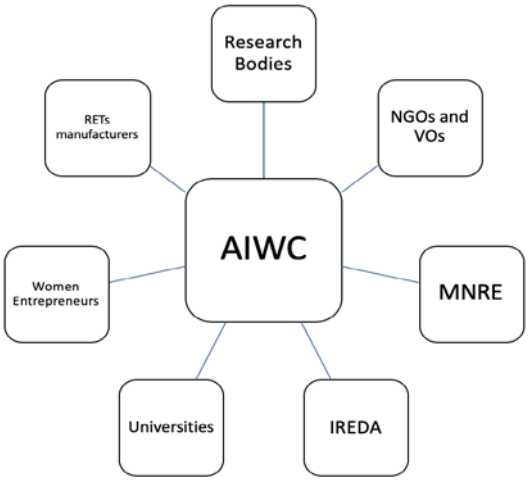
entrepreneurs with a mix of some who were either being trained or those already running their solar energy-based enterprises for at least 2 years. Participant observation and key informant interviews were conducted during field visits. In addition, secondary data from AIWC such as case files and reports, white papers, project evaluation reports and portfolios were consulted for this research. In both places where fieldwork took place, the regions have experienced a wide range of similar initiatives from renewable energy-based institutions and actors involved. The research, therefore, made use of both primary and secondary sources of data. For the primary data, a semi-structured questionnaire was used along with participant observation method which had two versions – one for selected women entrepreneurs and the other for AIWC staff members supporting these entrepreneurs through training, helping to develop business ideas and management of the same, providing finance and helping to access new markets.

Findings and Analysis

Investigating the Patterns of Interaction and Outcomes Generated

By looking at AIWC's operational model and the extent to which they regularly interact with a broad range of (see Figure 1) - main clients are women entrepreneurs, research bodies, MNRE, rural cooperatives and IREDA. Besides the NGOs and VOs, the AIWC also buys RETs from private RETs manufacturers such as TATA Power Solar and *Urja* Unlimited; they also organise training programmes so that women in relatively disadvantaged communities can learn how to make basic RETs at home and develop micro enterprises based on it. It is thus important to understand these different stakeholders and their patterns of interaction to study what outcomes are generated for solar based entrepreneurial initiatives. Codes are identified in each of these sections that would help in the thematic analysis presented later. Looking at the range of services that AIWC offers to their clients, the following are discussed.

Figure 1: An illustration of stakeholders of AIWC



Source: Adapted from Mukhopadhyay (2017)

Partnerships to Facilitate Training and Development Programmes

Some primary and also major impediments to any solar-based micro enterprises sources from lack of basic and practical knowledge. The women and youth who are running the solar-based enterprises are not able to solve the minor problems of solar devices & maintain, repair and install the solar devices. Consequently, they are dependent on external sources and that can be both *costly* and *time-consuming* process. Thus, the aims of training programmes conducted by the AIWC have been to identify and enhance the capability of low-income group of women/youth from identified resettlement colonies to develop into potential entrepreneurs to assemble, repair and maintain solar devices/energy efficient devices and create a self-sustaining model and local eco-system. The model shall result into a successful demonstration that a women/youth group could be successful entrepreneurs and contribute to consequential and value (monetary) generating livelihood activities.

> *"The training programmes are easy to follow and have a good organisation of resources, we basically start from zero in terms of technical knowhow but we're familiar with the usefulness of the RETs as (NGO) colleagues have talked about that earlier. This provides a good starting point. Women are particularly focused on understanding how to*

> *make use of the RETs to run a business that can be home based, income-generating and involve other women from the local community*"

The training programmes that AIWC designs and sets up are either in resettlement colonies in New Delhi or in the suburbs around Noida, there have been around 15-20 trainees in each group. The time period of each training program has been approximately 1 month with 20 sessions that contained both theory as well as practical classes. *Urja* Unlimited provided the technical training and products (e.g., solar lanterns, home lighting system & LED devices) for these programmes. With an increase in discussions around climate change and global warming, products such as solar dryer, parabolic and box type cookers; waste management, vermin compost, biogas, self-help group formation & Peat Pot development have been taught by experts from the industry who were hired as consultants. AIWC staff gets invited to cover the exhaustive syllabus for both theoretical as well as practical classes. At the end of each training programme, there is a test and evaluation session. These training programs had been conducted in the supervision of training-convener and trainees had been selected with the help of local NGOs and the local contacts.

> "*One month is a less fragile period of terms of holding up to their motivation; what I am learning is less important than how is it going to affect me after the training is over is what the participants carry in their minds. So, 20 sessions in one month involves quite a lot of training input, and they do take these in before they are evaluated where most of the participants have been noted to get a pass there are some really smart women who continues to stay in touch and look for further training programmes*"

The above quote captures the strategy of the programme design and content, it is to be noted once again that the participants are mainly poor or from relatively less poor categories of the society, so it does make sense not to design programme that will probably going to take them off from their daily lives for a longer period of time leading to possible drop outs. In regards to selecting 15-20 participants in each group, it is highly important to note that in most of these programmes, there is often more than 1 trainer per group, there is usually an additional facilitator who also responds to individual queries and address problems encountered by the participants. The training programmes are highly hands-on, and this allows the participants to get

individual attention from the trainer and the training assistants, this leads to higher efficiency and thus clearly more involvement during the process.

Engaging Unemployed Youth/Women Who Are Potential Solar Engineers

The end goal of AIWC's training programmes is to provide an opportunity to trained women/youth to do the following.

1. Engage with solar manufacturer and service firm and to establish their own service centre
2. To create income by providing service as maintain, repair and installation of solar devices
3. To maintain their own solar based charging station
4. To start a sales centre

At each of these stages above, it involves a range of actors that contributes towards the final outcome. It has to be noted that the participants are usually allotted a time frame to engage in the process with a specific firm. Since AIWC is also the nodal agency for the MNRE (Ministry of New and Renewable Energy), it has got quite a commendable list of networks of firms that they can closely ally with to support these individuals (youth/women). Upon completion of the apprenticeship period, the individuals are then supported to set up their own solar charging station, or a maintenance store where users can come down as a one stop troubleshoot store. These trainings are usually provided during the training and awareness campaign as discussed in the earlier section, and it has been observed that in most cases it is the women who set up the maintenance and repair shops where men are found to set up solar charging stations. The role of NGOs is also key here to the success of these initiatives because it helps in collaborating with multiple stakeholders at the grassroots.

Once these individuals are found to be set up as a solar engineer, there appears to develop a trend in the colonies or in the suburbs where neighbors of these newly built entrepreneurs try to step up and do something similar. This would involve not only to set up newer and more solar charging stations, but includes the use of solar lanterns and solar cookers to set up mini stalls and small business around their living areas. The community develops over time consequently.

> *"Rita was managing her maintenance shop for over two months and she secured around 20 clients who came on a repeat basis with their cookers, lamps and batteries, over time her neighboring family decided to use one of the lanterns given for free by the NGO to use it for selling garlands in the colony after dark for customers returning from offices after 7pm. This trend was missing before because people haven't used these technologies before but now, they realise the technologies are giving them additional opportunities, time and money"*

Partnerships Across Regions on Potential Incubation

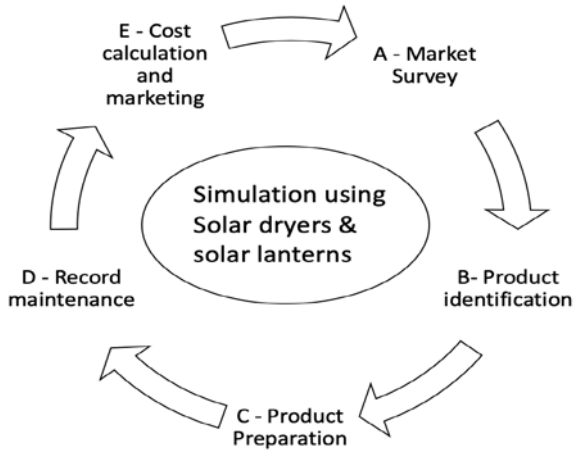
AIWC tested simulation using solar lanterns and solar air dryers, these two being the most popular RETs used by their entrepreneurs. For the solar air dryers, the AWIC launched two very similar schemes in two different parts of the country in 2011. First in New Delhi followed by installing the same capacity in Kerala in South India. Interestingly, one succeeded while the other did not and this simulation was particularly useful for building up the lessons learnt and knowledge database. *Primary* objectives were to demonstrate the commercial viability of solar drying of fruits & vegetables on a micro-enterprise scale and also to establish its suitability for wealth creation among the poor women. *Secondary* ones were to study the market for dried/processed fruits and vegetables in general and solar dried/processed products in particular; in addition, that the objective was also to explore the various means of structuring the solar drying project in terms of financing and asset ownership; also, to establish a set of specifications for solar dryer (hardware) and processing technology (software) for the various dried/processed fruits and vegetables. A case is presented below to clarify how the RETs business simulation was run. (AIWC, 2013)

Drying of fruits and vegetables is one of the chief means of preserving the wide variety of seasonal fruits that India abounds in. Among the many techniques of drying, sun drying is widely practiced. In India, hardly 2% of the horticultural produce i.e. fruits and vegetables are processed whereas countries like Thailand, Philippines, and the USA process more than 70% of their produce. The fruits and vegetables processed in the form of fruit pulp constitute 50% and dehydrated products only 2.22% i.e. 33,000 tons per annum (AIWC, 2008). Solar Drying Technology offers an alternative (to sun

drying) with zero energy cost and processes the vegetable and fruits in a clean, hygienic and sanitary condition of national and international standards.

AIWC realised that the solar dryer technology can be utilised in small-scale food processing industries for producing hygienic quality food products while at the same time this would promote renewable energy sources in income-generating unit. They had some success with it in New Delhi in the past, so they decided to go ahead and replicate the model in Tamil Nadu. The process had two parts, firstly, training and installation of dryer in four locations and secondly, to carry out production on experimental basis. Experiments were done with different products in different locations based on available resources and demands along with the validation of technology. Mango bars, ginger powder, need powder and fenugreek powder for diabetic patients, desiccated coconut powder - are some of the many products.

Figure 2: Steps identified in the Sample simulation using solar lanterns and solar dryers



Training Programme included demonstration on mango bar processing in solar dryers in the selected regions. The program basically focused on preparation of mango bars. It also gave demonstration on processing of tomato, ginger, coconut, green chilies, curry leaves, and mint leaves using solar dryers. Trainers demonstrated the use of the RET, participants found the solar dryer very good for use in the micro-level food-processing programs that are ideally suited for self- help groups. In Kerala, solar dryer training was a five day intensive training program with 13 beneficiaries, 10 from SHGs

(self-help groups) and 3 from *Mahila Samagam* branch. 17.3 kg of mango bar was prepared as a part of training.

Table 1: Marketing of solar air dryer products

Product Preparation Steps	Marketing Details
1.The products were identified on the basis of season, fruits and vegetables available in the local market and market survey 2.The branch in Tamil Nadu experimented with tomato powder, curry lead powder, kasuri methi and bitter gourd powder. 3. Delhi pilot prepared dried tomato slices, kasuri methi, mango. Bars, kadi masala powder, tomato powder, amla powder and ginger powder. The members at Delhi centre dried basil, pudina and drumstick leaves.	1.The prepared products were sold at the calculated prices based on the production cost. A percentage of packed products were supplied as samples to retailer and canteens for testing. Till the pilot stage all the solar dryer units were promoting marketing through known linkages. 2.At the Delhi centre, packs of tomato slices were distributed, as samples to specialty outlets, restaurants and other products were sold through AIWC counter at main branch. Mango bars, methi leaves and ginger powder were sold like hot cakes.

Table 1, above, shows the marketing procedure. The market study at Delhi and experiences revealed that mango bar toffee can be marketed through school canteens and can fetch a good profit. Kerala unit tried to market the products through known linkages. While Tamil Nadu pilot experimented with tomato powder, kadi leaf powder, kasuri methi, mango bar and bitter gourd powder, the pilot in Delhi tried tomato powder/slices, kasuri methi, kadi masala powder, mango bars and ginger powder. Pilot in Kerala experimented with curd green chilies, curd bitter gourd, black pepper, rice wafers and tapioca wafers. All the products were selected carefully on the basis of availability of raw materials.

Results showed that dried tomato slices/powder was prepared at Tamil Nadu and Delhi pilots. At Tamil Nadu about 1.7 kg of tomato powder was produced and 1.65 kg was sold which fetched 25% profit. Solar dried tomato powder was preferred in Chennai as tomato finds a very prominent place in South Indian cuisine. Delhi pilots prepared tomato slices and powder but faced a loss of 47%. The reason was one batch got fungus infestation due to

humidity in rainy season. Again, consumers did not prefer dried tomato slices. These products find market in specialty stores who already had supply linkages with other enterprises. Tomato powder produced by Delhi pilot was received well in the market because consumers used the powder to make tomato soup.

Lesson 1: *Tomato powder is more profitable to produce in Southern India*
Lesson 2: *'regional conditions and consumer preferences' needs to be considered as a determining factor for solar air dryer food products. The choice of solar technology isn't the key condition*

Kadi Masala powder is prepared by mixing Kadi Leaf powder with red chili powder, channel dal powder, dhania powder, garlic powder, salt and refined oil. The powder is used in South Indian Cuisine and North Indians also use the same in curd to make it spicy. Delhi pilot prepared the kadi masala powder. The consumers appreciated the product and encouraged the unit by placing orders. The product was found marketable in Delhi market.

Lesson 1: *Product rightly identified and marketed*

Lesson 2: *Regional condition and consumer's preference is after all an important determinant before setting up a RETs generated food based micro enterprises*

Summary of key lessons learnt and shared from the case

The project experiences will be used in the recent future when a SHGs or individuals will use solar dryer concept in an enterprise. Project provides sufficient space for the women to use the experiences for income generation. This will not only fetch income for the women but will also cultivate entrepreneurial ability and self-reliance amongst them. The products should be identified on the basis of cheap raw materials available in the raw market. It's better to prepare the products in the season when the local market is flushed with the raw material. Otherwise, a tie-up could be made with the farmers that the unit will buy a particular amount of the harvest at wholesale price. Due emphases should also be given to consumers' preference in the local area. A particular product is preferred in Delhi market but is rejected in Chennai market because of differences in food habits. Market research should be done for local market. Initially the product must satisfy the nearest market

demand, as it will make the marketing easier. Each product should necessarily bear the message that the product is solar dried and hygienically prepared.

Develop Self-Sufficiency in Youth/Women to Run Energy-based Businesses

AIWC runs a series of initiatives starting from running awareness and training programmes to setting up small firms installed with solar charging stations to replicating successful models elsewhere to increase the organisational knowledge database. In the process of doing so, the development of self-sufficiency in youth/women to run energy-based businesses is visible.

> *"The feeling of self-sufficiency takes a long time to develop, it starts from the training programmes when they (the participants) are informed about the prospective benefits of running an energy-based business and that they don't have to rely on their local municipality or gram panchayat anymore to avail their social protection benefits. Women were also told that they don't have to migrate out from their base and most of the initiatives can be home-based and they can send their kids to the school. We provided adequate training to these women for over 20 years now, for various different initiatives, it started off with the simple technology of parabolic solar cooker which was new at that time, and now solar charging stations that are quite popular in the communities these days"*

Two more things observed here – *firstly*, the concept of security and stability of women in their home area. Generally, men are more likely to migrate out than women running renewable energy-based businesses. The assurance that AIWC provides plays a vital role in securing the expectations of the women that the business can be run from home without the need to move out and leave an established set up. *Secondly*, the entrepreneurs are made known that AIWC starts their supporting mechanism from early awareness meetings through the process of training and nurturing entrepreneurial capacities in the entrepreneurs to guiding them till the

business takes off. This is a great support for entrepreneurship at any level for both motivational, stability and security purposes.

Discussions and Implications

The public-private partnership model visible in the AIWC's operation is interesting. The actors that are involved with the AIWC at different levels are NGOs, MNRE, IREDA, renewable energy manufacturers, trainers and leaders from University as well as industry. For each particular purpose, starting from *awareness campaigns* (partnering with NGOs), *sponsoring training programmes* (partnering with MNRE and IREDA), *providing technologies* (Urja Unlimited) to *building entrepreneurial capacity* by development workshops (trainers and research agencies). These actors are thus vital components of AIWC's working model. In particular, the role of NGOs is undermined but the importance of awareness raising programmes are vital because the RETs and initiatives to develop women entrepreneurs requires a societal support and especially from the households where they belong to. A big part of the operational success of any such initiative calls for a well-nurtured and sensitised community where they have been made aware of the benefits and challenges of adopting a change.

Table 2: Data Analysis Structure for AIWC

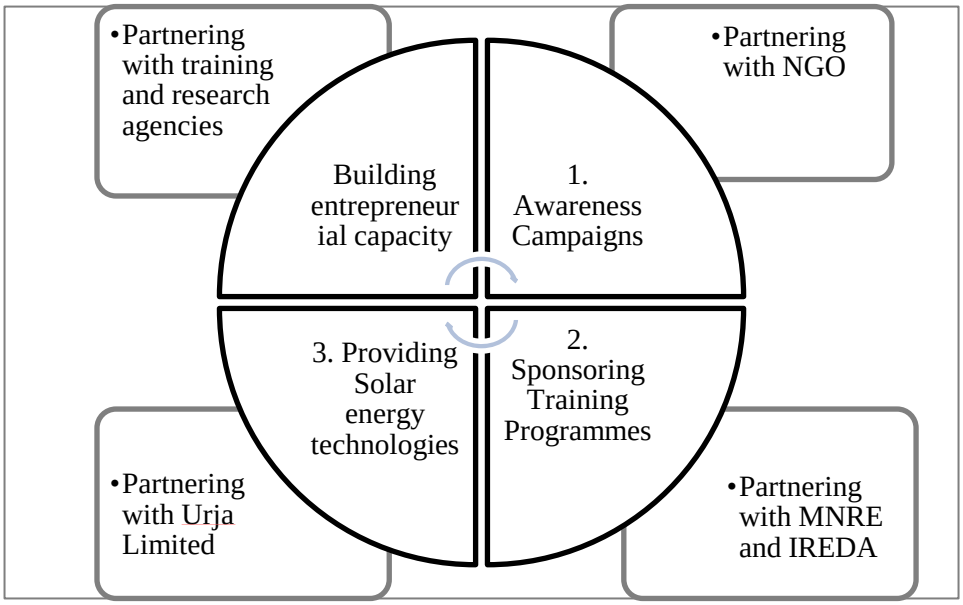
Patters of interaction and outcomes generated	**Codes**	**Themes**
Working with partners to facilitate training and development programmes	1. Practical training 2. Skills-based test 3. Simulation Programmes 4. Guided and participatory process	**Participatory training and learning, simulation opportunities**
Engaging with unemployed youth/women who are potential 'solar engineers'	1. Support from apprentice to start-up stage 2. Participatory learning support 3. Women maintain and repair solar technologies	**Comprehensive long run entrepreneurial support, women repairing RETs.**
Working with partners in different regions to replicate	1. Importance of situational factors	**Situational factors of business, identifying right business and**

Patters of interaction and outcomes generated	**Codes**	**Themes**
	2. Inclusion of entrepreneurs as a part of the simulation to share learning 3. Identifying the right business to choose and grow 4. Cultivate entrepreneurial ability	**region specific, funding available for start-ups**
Develop self-sufficiency in youth/women to run energy-based businesses	1. Early awareness meetings 2. Developing a sense of independency 3. Ensuring stability 4. Support from training stage to business take-off	**Focus on awareness and knowledge sharing, entrepreneurs developing a sense of self-sufficiency**

A 'Participatory Approach' in Training, Learning and Simulation Opportunities

The cases cited earlier in the paper shows that training and learning programmes are developed and run by a host of institutions that are partnering with the AIWC. During the training programmes, trainer and facilitators coming in from Universities and research institutes participates and interacts with the entrepreneurs in person, shaping it like action-learning and answering any questions. The opportunity provided for business model simulation enhances a higher understanding of situational factors that play a large role in ensuring potential business success, especially in the case of food business where entrepreneurs are trained to use solar air dryer. The knowledge of lessons learnt ensures that the learning process is continuous both for the entrepreneurs as well as AIWC as an institution.

Figure 3: Identifying stakeholder partnerships and interaction levels for AIWC



Provision of a Holistic and Long-run Entrepreneurial Skill-building Support

As evidenced earlier in this section, AIWC help in building women 'solar engineers' who are also entrepreneurs boosted by various initiatives. In some cases, men are leading a solar charging station while women are repairing and maintaining the technologies. The process that AIWC follows to build women entrepreneurs is a journey with several steps and over an extended timeline. They start by *awareness campaigns* whereby the benefits and challenges of using RETs are explained. This includes not only explaining the benefits of using renewable energy technologies or becoming an entrepreneur; but also making women more aware of societal issues such as they do not need to leave their community and the business can be based at home – this ensures a sense of stability and security. Awareness campaigns, training and development – being the initial steps, the institutions also offer finance to support a new start-up while providing business training and knowledge support. After a business takes-off, AIWC also remain in frequent touch to see the progress of the enterprise and helps in further scaling up in the future.

This is largely missing in most other development impact initiatives in rural areas.

Situational Factors of Business - Identifying the Right Business and Region, Accessing Start-up Capital

> *"It was important to learn what were the food habits of people in order to popularise the solar cookers and solar dryers and solar pumps while working with tribal area in Mozda, Gujarat, before any change was introduced. What kind of cattle the household has for instance norms could for a gobar gas plant is viable for 5-6 cattle? It is not always the number but also the health and the nutrition available to the cattle would be accounted for. Rigid specifications would lead to failure. Sometimes the Government officers had gone making structure for gobar gas plants without training or involving the people. NGOs and Government need to work as active collaborators to popularize these technologies and make any programmes successful. Thus, for any organisational working closely with the grassroots needs an entire set of local knowledge at various levels in order to start designing program planning and approach"*

MNRE and IREDA are the two other key actors that the AIWC closely collaborates with, this is firstly because MNRE had appointed AIWC as its nodal agency to disseminate technology and training campaigns on non-conventional energy in different regions of the country and secondly, IREDA provides the seed funding for all programmes and initiatives that AIWC comes up with. This also acts as a security because in several cases (as the solar air dryer case in Kerala), some of the costly initiatives may not generate expected result. The renewable energy manufacturers are, however, a key actor for AIWC, this is because the nature of demand has been constantly changing and thus the consequence on cost. AIWC's wide network of manufacturers, considering it is a nodal agency for the MNRE, brings in the best deals with guaranteed maintenance provision in the country. AIWC also brings in industry experts from both the RE industry and the Universities – and these actors can be seen providing training in their awareness

programmes. This evidences that this sector has activised and benefits from the triple helix relations at play.

In addition to the above factors, another common phenomenon noticed from most of the initiatives that AIWC have taken up, especially the recent ones (over the past 10 years) with renewable energy technology development and dissemination of the same to rural masses, is the continual involvement of voluntary agencies. This has clearly increased public awareness of various energy-saving devices and people have expressed a higher level of interest and perception of the same due to the fact that these voluntary agencies work closely with the communities and households to help them understand/accept any change. This is important because in rural areas, no new change or a technology so to speak, can be introduced without an initial stage involving 'sensitisation', and this is very much possible with the action and involvement of voluntary agencies. The initiatives and activities of AIWC over the years have set an example for several other institutions, both at the regional and national levels to develop rural livelihoods especially by targeting and benefitting women in peri-urban and rural India by providing non-conventional technologies alongside providing adequate training and business support.

AIWC also organised a wide range of awareness programmes on other technologies like the use and maintenance of biogas plant, solar cooker improver and other RETs sources such as wind mills, solar stills, solar drier, solar lanterns. These became a regular series of programmes under the wing of '*strategies for mainstreaming women in science and technology, policy formulation, development and dissemination'*. Since AIWC is one of the key and dominant nodal agencies of the MNRE, funding and access to resources is not a problem and thus the programmes were ably demonstrated in different parts of the country on a regular basis. This ensured consistency and regularity which kept up the motivation and interest of the growing pool of participants who became advocate on using RETs for creation of income-generating micro enterprises.

Implications and Conclusion

Firstly, in light of the findings of this study it is crucial to acknowledge and understand the importance of knowledge of the local context and situational business factors. Having active hands-on knowledge partners helps design and develop better support mechanism. *Secondly*, the case study

evaluations in this paper strongly suggests that rigid technical specification may limit the success of the programmes, e.g., when Government officers tried to make structure *gobar* gas plants without training or involving the people, programmes have failed. *Thirdly*, when technologies are designed tailored to region-specific conditions, it has been found that they can be transferable. *Fourthly*, the many benefits that triple helix relations in this sector brings.

This study explored and analysed a large number of training programmes organised by the AIWC that were also micro-enterprise specific, e.g., the solar cooker and solar battery charger programmes was meant to train women and youth to be self-sufficient to run their charging station without external support. The objective was to engage unemployed women and youth folks to become 'solar engineers' to cater to local energy needs, establish their own service centre, create income by providing service to maintain, repair and installation of solar devices. The local actors, NGOs and VOs, have been the knowledge partner of these training programmes. These programmes had a model of a social enterprise that provides solar energy solutions and service to enhance livelihood opportunity and entrepreneurship in rural areas.

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