Community Development by Employing Photovoltaic Solar Sewing

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Abstract: A person's culture must be respected before embarking on mass roll-outs of a new innovation. The pedestal of culture rests on the following often non-negotiable legs: language, norms, values, beliefs, roles and social collectives. These are briefly explained before reporting on the experiences of various parties intending to roll out their innovation towards the social development of communities. Examples of failures are cited like smokeless stoves where the community was not consulted beforehand. Similar failures were reported with the solar cookers from Europe. Subsequent interviews revealed practical reasons for the non-acceptance by the local community. The approach of marrying culture and technology beforehand is thus emphasised. A classic example is to be found with the successful conceptualisation, development and commissioning of a patented 12v DC solar photovoltaic sewing machine. It was deployed in a remote, rural area of the North-Western Cape of South Africa. The world's first solar sewing station, earning money for unemployed housewives was developed at Kliprand thanks to the financial support of USAID and the South African Foundation for Research Development (FRD). Before launching a development project one needs to ask: Why is my innovation viable? When is it viable? How viable is it now and in future? Where is it competitive? The Conclusion of this paper will therefore almost serve as a guideline for well-meaning developers for Africa and beyond.

Keywords: Culture, innovations, job-creation, guide-lines.

1. INTRODUCTION

In many developing countries basic research in the sciences is too expensive to be funded. Even applied research in the technologies is often considered to be a luxury, unless the results can be seen to be implemented in the community. An attempt will thus be made to discuss how findings resulting from applied research can be made more palatable and acceptable to be implemented on the African continent and beyond. A broad-based approach is proposed and the author will draw on knowledge gathered from his three Master's degrees and a PhD from different faculties of different universities. The 25 years of practical experience as Director of Research of all faculties at the Cape Peninsula University of Technology, Cape Town, qualifies him to apply the lessons learnt from actual developmental projects conducted in South Africa.

Fundamental to this discourse is for the researcher or developer to recognise the values of the culture one is dealing with. It is therefore fitting to digress for a moment and discuss what constitutes a typical culture. This essential approach of marrying culture and technology will subsequently be discussed in more detail. Various project successes and failures experienced by some potential well-doers will be cited. A classic example is to be found with the successful conceptualisation, development and commissioning of a 12v DC solar photovoltaic sewing machine [1]. It was deployed in a remote, rural area of the North-Western Cape of South Africa. This specific area was chosen, since it had no electricity supply and the village of 53 houses offered no employment to its inhabitants. Should government wish to develop this region then solar energy would be only one of the many other elements of infrastructure that require attention.

On the other hand, well-meaning overseas entrepreneurs have had the brainwave to flood Africa with solar cookers [1]. Such campaigns have not been very successful, since the locals prefer meat which is grilled or 'braaied' instead of cooked. Smokeless cooking is traditionally not acceptable. Respondents have also told researchers that the womenfolk cannot watch over such slow cookers, whilst they are busy trying to earn a living elsewhere. During their absence, both food and solar cooker, which have to be based outside, would invariably get stolen.

2. THE IMPORTANCE AND VALUE OF CULTURE

Most people are very proud of their own culture, no matter how primitive or non-technical it is. The reason is to be found in the six basic elements identified by

Google's Flat World Education [1-3], which are briefly discussed below:

2.1. Language

Language is the basis of interaction and communication among people.

According to Hornby [4]: '*Language is the human and non-instinctive method of communicating ideas,*

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feelings and desires by means of a system of sounds and sound symbols'. Language has been called the transmitter of culture from generation to generation [1]. It is also the carrier of messages, which have to fit the target audience, which may change from area to area or from time to time.

The word 'flat' in the United States, implies that a wheel of your car has a puncture, whereas in the United Kingdom and Africa you can live in a flat, like in an apartment. In southern Africa we commonly refer to a hot-water cylinder as a 'geyser'. In other parts of the world, a geyser is a drunkard. The dialect, or pronunciation of words, may also greatly vary.

2.2. Norms

Norms are the '*expectations and rules of behaviour created by external or internal social control's*. The same mistakes as were discussed under language, may also be made by resorting to false pictorial presentations. A large local soap manufacturer mistakenly showed a toddler in a bath wearing a beaded charm, which is normally only worn by a Zulu virgin.

2.3. Values

Values are '*the things that people consider important such as love, loyalty, hard work, compassion, knowledge and humanitarianism'.* Dr Martin Luther King spent his lifetime fighting for these, as perceived by his supporters. *Values* represent 'a society's ideal culture and social standards, but may not reflect how people actually behave'. Hornby [4] adds that '*value is the quality of being useful or desirable, as well as the value of something in terms of money'.* In most parts of Africa, a work ethic has to be taught. Colonialism has been blamed for depleting Africa of its mineral resources. Unfortunately, corruption seems to be rife in most developing and even in some developed countries, leading to poverty among a large portion of the community.

2.4. Beliefs

Beliefs are the '*things that most people in a society consider to be real and true'*. This is where the public and the social media currently play a most important role. Years ago it was generally believed that 'acid rain' [5] was entirely due to exhaust gases from industry and vehicles. Scientists eventually identified a disease, which caused the leaves to drop off trees. Later vehicles got the blame for the 'ozone hole' [5]. Sceptics are still waiting for answers to the fact that relatively unindustrialised Africa with its few cars had a far bigger ozone hole than industrialised Europe and the United States with their many cars. Due to a massive collusion between politicians and journalists, the public at large started believing in 'global warming', even at the total exclusion of data from the Antarctic and NASA. Supporters have now wisely chosen the term 'climate change', which has been around for centuries even during the ice ages.

2.5. Roles

Roles define 'a person's task or duty in society or in an undertaking, for example: a person's responsibilities due to his or her position, power and wealth.

Formal *roles* describe who is responsible for what and they are absolutely essential for the success of a team. Informal roles, on the other hand, are not assigned. Instead, they are assumed by individuals, because of their personalities, motivations, individual styles and attitudes, or the ways that they like to approach situations or tasks. Collectively, a government's *role* or function is to govern a country properly, as expected from its subjects.

2.6. Social Collectives

Social Collectives [6] refer to the togetherness among a group of people; society; or from the same culture; or nation. Scientists and engineers are key participants in propagating ideas about the nature, purposes and social significance of their work. In commerce, a collective agreement is often one negotiated 'collectively' between management and trade unions or employees.

These fundamental elements of culture are never static. Developing countries, like South Africa, usually experience a rapid shift to urbanisation. In city life there is a major interaction of many cultures, which often promotes the improved use of existing technologies. These include: running water out of a tap; flushing toilets; electric lights and power by merely operating a switch, provided there is no power outage, etc. In developing areas, '*Things are trustworthy, because the neighbour of the same culture has said so'* [5].

3. SOLAR ENERGY

To the reader unfamiliar with solar energy it is important to note that there are two main streams or types. The thermal systems merely depend on the

warming of say water left in the sun. Solar thermal is being used extensively for hot-water systems in the home. The water can be heated either directly or indirectly with the assistance of a panel or evacuated tubes. A hybrid system consists of using electricity from the central supply to top up the solar system, in cases where it does not supply sufficient energy on its own. This may be due to an under-design or on days when the sunshine hours are too short [7].

The other main branch of solar energy, which constitutes the main topic of this paper, utilises photovoltaic (PV) panels. They convert the energy from the sun into electric power or electricity. The power thus generated may be used directly, like pumping water via a 12vDC pump. A more conventional use is, however, to store the liberated energy in a solar battery, similar to a car battery. In many developed countries, the private consumer is permitted to feed the excess electricity back into the grid of the power supplier. After 6 or 12 months the consumer is credited with the power sold to the power supplier. Even in countries where this is not yet possible or in countries where the grid system of electricity is unreliable or inadequate, the PV solar system still offers a good alternative. In areas where the solar irradiation is reliable and high, PV solar may also be used as an alternative to a stand-by power generator. PV solar energy thus offers a good alternative in areas where there is no central supply of electricity [8].

Before just jumping in to follow the global trend of utilising renewable energy to combat the alleged evils of climate change one should nevertheless find answers to the following pertinent questions [5] :

When is PV solar energy viable? Only if prevailing natural conditions favour it; provided demand matches supply of renewable energy; provided its installation is cost-effective; and provided the end-user is familiar with its limitations.

Where is PV solar energy viable? In un-electrified, rural areas of developing countries, where incidentally 50% of humans live; for better lighting in rural areas by replacing dangerous candles, oil lamps, and paraffin hurricane lamps. It could supply villages with power to create communal jobs and stimulate economic development. If used as a stand-alone system as a battery-less PV installations for pumping water; or solar sewing, when the sun shines; or if used as a hybrid with other sources, e.g. solar pre-heating of water for a hot-water cylinder.

Why is PV solar energy viable? The cost of solar panels relative to other renewable energy sources, has decreased appreciably in recent years.

In South Africa the use of renewable energy was discouraged by the national electricity grid for decades for fear of destabilising it [5]. After a common REFIT (Renewable Energy Feed-in Tariff) scheme failed a new partnership with the State was announced in August 2011. This is an excellent solution in cases where the State no longer has sufficient funds to spend on generating additional power [9]. A unique bidding process of REIPPP **(**Renewable Energy Independent Power Producer Programme) is to serve the country with Solar PV up to 1 450MW and Concentrated Solar Power (CSP) up to 200MW, out of a total 3 725MW of renewable energy power. Although CSP is still relatively expensive, it has the unique advantage of still delivering power for a few hours after sunset.

4. SOLAR SEWING FOR COMMUNITY DEVELOPMENT

This section highlights a successful solar PV project from an idea; to a concept of an innovation; to the construction by students of a prototype; which was patented; to the actual commercialisation of a battery-less, solar PV, 12vDC sewing machine and over-locker. A brief survey by a German exchange student based in the Author's Energy Institute of the Cape Peninsula University of Technology (CPUT), Cape Town, indicated that mothers in rural villages would like to learn to sew. The driver of this wish was to create jobs and to alleviate poverty. Having just returned from Germany as a Humboldt scholar, it was decided to do something in Africa which had never been done before. A conventional 220v AC electric sewing machine was to be converted to a 12v DC solar PV driven sewing machine. Researchers from France had already indicated earlier that the most reliable 12v DC motors were to be found in motor vehicles. Tests showed that a car's wiper motor might fit the bill. Amongst laughter from a neighbouring university the conversion was completed, but the speed was far higher than what a seamstress had ever experienced. So a speed controller was designed, built and later patented. A seamstress, Mrs Martha Neslon, from the adjoining Textile Department taught the researchers that a sewing machine has to be driven like a car – going slowly round corners. The first acceptable prototype was built in Cape Town. The patented, battery-less, PV solar sewing machine is still on display in the Visitors Centre of the National Renewable Energy Laboratory

(NREL) based in Golden, Colorado, United States. Students from three different African states then mass produced 20 converted sewing machines and three converted over-lockers to enable the user to sew stretch material for making vests, etc.

The South African Foundation for Research Development paid for a bank of PV panels. The idea was to actually create a solar sewing station in the heart of a village without electricity. In spite of the energy authorities not wanting to identify such a site for fear of being discriminated against, previous tourism experience came to the aid. Kliprand, a village of 53 homes without electricity in the North-Western Cape, was chosen as test site for this community project. Here the richest person appeared to be a retired school teacher. Fortunately, Kliprand has of the highest solar radiation in the world averaging 850 MJ/m^2 throughout the year. The continent of Africa has the highest annual 24 hour global solar radiation average of approximately 220W/m^2; compared to the United States of 150W/m^2; and Europe of only 100W/m^2. Observers therefore invariably think that African states should take a far greater advantage of solar energy. Many countries in East and Southern Africa enjoy over 300 days of sunshine per annum. The radiation levels in many African countries lie above 8000MJ/m^2 per annum. Our inland region of the Northern Cape, bordering on Namibia, is ideal for solar installations and yet the country still had under 20MWp installed PV capacity in 2015. The chosen Northern Cape Province is the poorest province of South Africa with a very low rainfall and high unemployment rate.

Hence it was decided to develop, build and commercialise the first 12V DC, solar PV-driven, battery-less, sewing machine station in the world, shown in Figure **1**. This was achieved by the Energy Institute of the Cape Peninsula University of Technology by carrying out the following steps [1]:

- Replace the 220volt AC motor of a conventional electric sewing machine with a 12volt DC car windscreen-wiper motor
- Develop the Energy Institute (EI) mini energy management system and speed controller, positioned inside the foot-control pedal. This innovation was patented under *SA Pat 96/3405*.

With this conversion kit three modes of operation are offered, retaining all advantages of a conventional electric sewing machine. The options are

- Direct connection to a 55 Wp solar PV panel per machine, or
- Connection via a solar-charged solar battery to be able to sew at night, or
- Direct connection to a car battery for a short demonstration period only.

Figure 1: Author displaying the essentials of the 12v DC, battery-less, PV solar sewing machine.

Over-lockers were also converted to enable the CPUT-trained seamstresses to sew stretch materials as used in the manufacture of vests, etc. The first meeting with the community attracted only men. They asked whether they could open the meeting with a prayer, thanking God for the sun and our team that had come to help them. We had no problem with this cultural greeting, but the absence of women remained a problem. Our response was that we were pleased that the men would give their womenfolk permission to join us with this project. This was the turning point and I was pleased to be able to report to USAID that our project was flying. It was the only one out of 4 or 6 others that was successful. Another similar project failed, because the researchers had spoken to the wrong tribal headman to start off with. This is mentioned, since rural communities often have their own cultural disciplinary code, which has to be observed [10].

A colleague of the Textile Department, Ms Martha Nelson, trained 20 ladies from the Kliprand village for 1 to 2 weeks. Most of them had never used a sewing

Figure 2: Clothing made at Kliprand, the World's first 12v DC PV Solar Sewing Machines.

machine before. One of them had, in fact, never yet seen an electric sewing machine. After the in-house training, all ladies managed to sew waist-coats, school uniforms, overalls, etc. During their first year of operation, the newly-trained seamstresses managed to earn R30 000 – in a village where there is no shop nor any business and where the top-paid resident is a pensioner. A proud grandmother is shown in Figure **2**.

5. UNSUCCESSFUL APPLICATIONS OF INNOVATIONS

In this section only two examples are cited in order to illustrate what can go wrong if one does not consult members of the community beforehand [1, 5].

5.1. Solar Cooking

Visitors to South Africa usually cannot understand why not more use is being made of the sun. This is a good observation for heating water, but for cooking there remain a few major hurdles, which still have to be over-come. These were experienced at great cost by well-wishing foreigners, especially from Europe. Surveys in our matriarchal society (due to many absent fathers) have shown that members of the communities in southern Africa experience the following partly cultural problems with this innovation:

- 'Who will prepare the food, whilst we are still at work and when we come back, the sun is long gone?
- 'When we come back home, both the food and this new contraption outside will be stolen, and
- 'Food without smoke does not taste the same and is not properly cooked'.

5.2. Low-Smoke Stoves

The Council for Scientific and Industrial Research (CSIR) decided to roll-out about 500 of their newly-developed 'low smoke' stoves in Johannesburg township of SOWETO (South-West Township) free of charge. The idea was that these would replace the polluting coal stoves, which were becoming a major health hazard in this densely-populated suburb or township. In fact, at one stage more children under the age of 7 years used to die because of smoke inhalation than on our roads due to traffic accidents [2]. After one year, when a follow-up study was launched, it was found that most people did not consider these stoves as a replacement, but rather as an addition – not for cooking, but for space heating, by a most energy-inefficient technique. One of the reasons given for this maladjustment was again that "one cannot cook meat properly, without smoke" [3]. This statement could be

substantiated by the popularity of a 'braaivleis' or barbeque among most cultures, instead of cooked meat.

6. CONCLUSION

The community-based research projects considered earlier are a fair sample of what technocrats may expect, when they venture forth out of their secluded laboratories into the open foreign market. Cultures are different and their norms and values have to be recognised, considered and embraced, before new innovations can be let loose – no matter how noble the intentions may be. Lessons learnt may thus be summarised as follows [5]:

- Conduct a needs study within the community to establish the relevance of your invention or new product, ensuring a reasonable demand and a steady future market.
- Involve the user community beforehand. Internationally, the nuclear lobby never seems to have done this properly and they are still paying the penalty of public resistance for this oversight.
- Demonstrate the innovation to the potential user illustrating the advantages like cost savings; time saved; convenience; as well as other advantages like health, safety, etc.
- Beware of public over-exposure, but listen to the customer feed-back. Even in the most popular field of communication, the initial mobile phone for speaking eventually, had the popular 'sms' mode and camera options added in order to remain competitive in a rapidly developing market. To the hardware options were added other gimmicks like links to computers, Facebook, Twitter, Linkedin, etc. It will be interesting to see for how many more decades the social media and all its branches will keep the public at large glued to a little screen, scrolling and rubbing its way through trash upon trash of unedited information and sensational news.

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