RENEWABLE ENERGY TECHNOLOGY AS CULTURAL CAPITAL:

The Hybrid PV-Wind-Diesel Case in the Village of Oeledo

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ABSTRACT

This paper has three main parts. The first discusses the concept of cultural capital and its relationship to the hardware-software-orgware concept of renewable energy technology. The second presents a case study of a hybrid photovoltaic-wind-diesel system that was deployed by the E7; then E8 and now Global Sustainable Electricity Partnership, in the village of Oeledo, Rote Island, Indonesia. The third analyses the case study focusing on the transmission of the objectified, embodied and institutionalized cultural capital (hardware, software and orgware) of the hybrid system from the E7 to the Oeledo community. Findings from the fieldwork suggested that for off-grid communities with no prior knowledge of renewable energy technology, all stakeholders should jointly invest in both time and resources, with a focus on orgware and software, to ensure a successful renewable energy project.

Keywords: acculturation of RE technology, cultural capital, hardware, orgware, software

INTRODUCTION

This paper explores the use of the concept of cultural capital, introduced by Pierre Bourdieu in 1986, to understand and overcome the challenges of introducing renewable energy (RE) technology, as a novel artefact, in off-grid areas. RE technology[1], viewed as cultural goods rather than merely equipment, can be described as a compound of hardware (equipment), software (information, skill) and orgware (institution, rules and network), corresponding to Bourdieu's concepts of objectified, embodied and institutionalized cultural capitals. Fieldwork experience in Rote Island in Eastern Indonesia revealed that, to be successful, RE delivery should involve more than just the installation of RE hardware. The deployment of RE hardware is relatively straightforward, however ensuring its ongoing operation is not. Software (the mastery of all necessary RE skills) and orgware (the presence of a local capable agent and or institution with a sufficient scope of authority) are required to maintain RE service continuity. Software and orgware may take longer to introduce and acculturate than hardware. They should be introduced prior to installing hardware and should remain throughout its technical lifetime.

CULTURAL CAPITAL AND RENEWABLE ENERGY TECHNOLOGY

Bourdieu (1986) first introduced the concept of cultural capital in the context of socioeconomic disadvantage to "explain the unequal scholastic achievement of children originating from the different social classes" by relating academic success to the

[1]Dobrov (1979) viewed technological system as a "three-dimensional technological entity" (Dobrov 1979, p85) of hardware, software and orgware, necessary to understand approach to modern "advanced-systems-integrated organized technology" (Dobrov 1979, p79).

specific profits obtained in the academic market (Bourdieu 1986, p47). Emmison and Frow (1998) used cultural capital, "understood as an alternative to the more traditional measures of socio-economic disadvantage" (Emmison&Frow 1998, p41), to "examine the relationships between IT usage and cultural capital" (Emmison&Frow 1998, p41) in Australian households emphasizing the significance of the domestic transmission of cultural capital. The two authors concluded, the "uptake of IT may be simultaneously conditional on existing accumulations of cultural and economic capital" (Emmison&Frow 1998, p44).

We could use the concept of cultural capital to explore the introduction of RE technology in off-grid areas, for example to compare performances of different households in acculturating RE. However, this paper focuses on the process of transmitting cultural capital, and the context is extended beyond the household level to examine the transfer of RE technology at the village level.

In "Forms of Capital", Bourdieu (1986) described the capitals available to a community or individual as being of three partially fungible forms (Bourdieu 1986, p47): 1) *Economic capital,* which is institutionalized in property rights and easily convertible into money; 2) *Cultural capital*, which is institutionalized in academic qualifications and convertible into economic capital under certain conditions; 3) *Social capital*, which is institutionalized in noble titles and convertible into economic capital under certain conditions.

Further, Bourdieu divided cultural capital into three elements (Bourdieu 1986, p47):

1) *Objectified cultural capital*, which he defined as "trace or realization of theories ... objectified in material objects and media, such as writings, paintings, monuments, instruments, ... machines, etc" (Bourdieu 1986, pp47-50). Thus we can consider RE hardware (equipment) to be objectified cultural capital, which is "transmissible in its materiality" (Bourdieu 1986, p50);
2) *Embodied cultural capital,* which he defined as "long-lasting dispositions of mind and body" (Bourdieu 1986, p47) possessed by an individual agent (eg. talent, autodidact), implying a biological constraintas "it declines and dies with its bearer" (Bourdieu 1986, p49). Thus we can consider RE software (information, skill) to be embodied cultural capital, which requires investment in time and effort for acculturation or "assimilation" (Bourdieu 1986, p48) in Bourdieu's terminology;
3) *Institutionalized cultural capital*, which he defined as "educational qualifications" (Bourdieu 1986, p50), instituted through education and training, overcoming the biological constraint of embodied cultural capital through replication. Providing access to RE education is a responsibility of orgware (institutions, rules, network).

In its objectified state RE hardware can be possessed materially as consumer goods by purchasing it if one has economic capital (or access to economic capital). However, to fully appropriate RE energy services, one first needs the relevant RE software, or RE embodied cultural capital. This requires a "process of embodiment, incorporation, which implies … a labour of assimilation" (Bourdieu 1986, p48) in which the appropriator must personally invest as, "like the acquisition of muscular physique or suntan, it cannot be done at second hand" (Bourdieu 1986, p48). Thus, if RE is to be fully integrated into village culture, villagers must first be actively involved in skill development as RE software (skill, knowledge) "cannot be transmitted instantaneously" by gift or purchase (Bourdieu 1986, p48).

The process of integrating RE technology into village culture also requires orgware to facilitate its transmission from the initiator to the appropriator (the village community). The process of transmission holds the key to the acculturation of RE technology. Villagers must view RE not merely as an alien artefact, but as worthy of becoming an integral part of the village culture because of how they believe that it would contribute to village wealth. Bourdieu insisted, "the most powerful principle of the symbolic efficacy of cultural capital no doubt lies in the logic of its transmission" (Bourdieu 1986, p49). Thus we need to design and implement the orgware and software of transmission as well as the more specific RE orgware and software. The village should explore the question of "added-value" prior to deciding whether to install RE technology.

At more general level, projects of this kind often have the objective of meeting the World Energy Council (www.worldenergy.org) objectives of Accessibility, Availability and Acceptability (3A) for energy supply. This paper highlights the importance of also considering Implementation (I). For more on this, see the discussion of the I3A Framework for project analysis and design in Retnanestri (2007).

THE PHOTOVOLTAIC-WIND-DIESEL HYBRID SYSTEM IN OELEDO VILLAGE, ROTE ISLAND, INDONESIA[2]

Oeledo is a coastal village located on Rote, the southernmost Indonesian Island, which borders on Australian waters. To visit this remote community, one must first fly to Kupang, the capital city of West Timor, then take a four hour ferry boat from Kupang to Rote's main harbour of Pantai Baru and then a final two hour journey by motorbike or robust 4-Wheel drive vehicle over a bumpy, hilly, rocky and dry road.

When visited in 2005 (Retnanestri 2007), Oeledo was home to 354 families and was a classic example of a remote community living in an isolated and dry climate. At that time, the subsistence livelihood was dependent on small fishing boats and Palmyra palm (*Borassus Flabellier*) trees. Figure 1 shows Palmyra palm handicrafts and Figure 2 shows Palmyra palm tree in the right background.

Fig. 1: Palmyra palm usage in NTT Province: 1) A couple with their hat handicraft, plaited from Palmyra stem; 2) A farmer tapping the palmyra drink; 3) Palmyra palm

[2]This section is derived primarily from (Retnanestri 2007, E7 2001 and Dauselt 2009).

drink (Neera) sellers with bucket, hats and drinking cup all made from the Palmyra palm leaves, May 2005.

Following a three year (1996-1998) feasibility study, socioeconomic and environmental assessments, site selection and procurement, in 1999 the then E7 (now known as Global Sustainable Electricity Partnership or GSEP), an international partnership of large electricity companies, http://www.globalelectricity.org/en/), in collaboration with the Government of Indonesia and the NTT (Eastern Indonesia) Provincial Government, installed a PV-Wind-Diesel hybrid power system, which was then operated by a locally established village electricity management committee (*Pengelola Listrik Desa*, PLD). This Activities Implemented Jointly (AIJ) project was designed as a prototype Clean Development Mechanism (CDM) project, intended to provide practical lessons in terms of technology transfer, capacity building and Greenhouse Gases (GHG) emission reduction target.

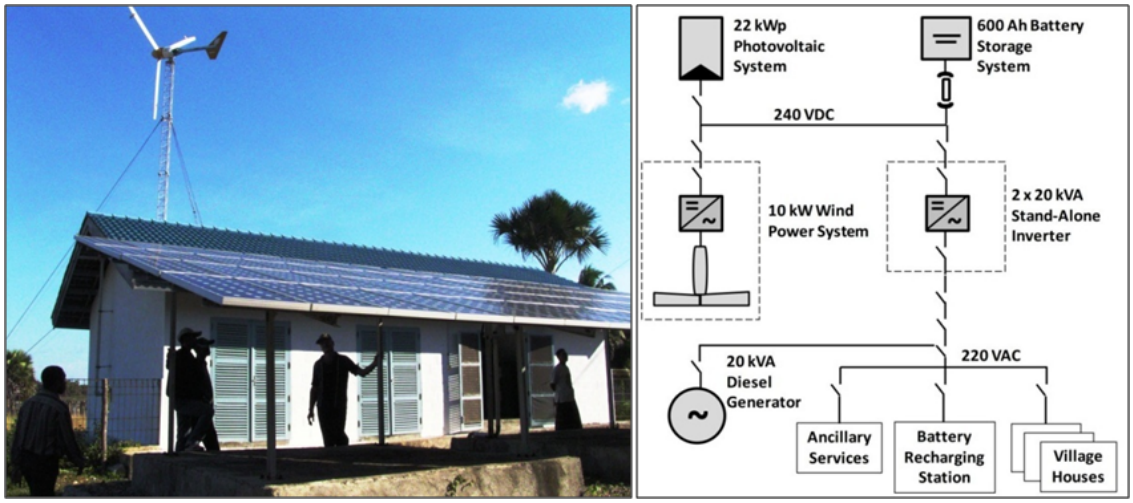

Fig. 2 left: The E7 PV-Wind-Hybrid plant and the PLD Office in Oeledo, 17/05/2005. Fig. 2 right: Single line diagram of the E7 Hybrid PV-wind-diesel system in Oeledo (reproduced from Dauselt 2001, p7).

Oeledo village was chosen because of sufficient solar insolation and wind energy resources, its isolation from the electricity grid and its socioeconomic situation with potential users, albeit poor, who showed a willingness and ability to pay for the operation and maintenance of the electricity service (E7 2001, p18).

The hybrid RE-diesel system installed at Oeledo (see Figure 2) comprises a 22 kWp PV system, 10 kW wind turbine, 20 kVA diesel generator, 600 Ah battery storage and 2x20 kVA inverters. Electricity is distributed to households by means of an overhead 220V single phase distribution system. The system provides an average of 48 kWh/day to the households, each of which has 0.5 – 2 Amp load limits.

Womintra, a Kupang-based NGO that was familiar with the local culture, facilitated the transmission of cultural capital. From one year prior to hardware installation, Womintra field officers (FO) were stationed in the village for up to two years to familiarize the community with the project, facilitate the establishment of the PLD and train the PLD officials in technical, financial and micro-utility management skills.

To avoid the so-called "drop-out syndrome" referring to "trainees leave the project after successful training" (E7 2001, p 33) a village meetings elected candidates for the PLD who were deemed reliable and committed. PLD members built the PLD office, defined the rules such as office hours, meeting schedule and penalty mechanisms for non-compliance. PLD meetings determined the salaries that the PLD officials would earn

and regularly reviewed system operation and finances. Withdrawal from the PLD bank account required two signatures - head of the PLD and the head of the village - to maintain financial integrity and transparency.

As shown in Figure 3, the project had three management levels to combine a top-down approach (E7, GOI and E7 Project Office (EPO) for project concept and design) and a bottom up approach (PLD and EPO level for project implementation, operation and management) approaches. Users were involved in the decision-making process through village PLD, focus group discussion (FGD), on-the-spot assessments and individual interviews for the non-engineering aspects. The villagers were initially sceptical about the idea of generating electricity from sunlight and wind although they were already familiar with diesel electricity supply. It took four years (1999-2003) for the facilitators to prove the ability of the hybrid electricity system to raise villagers' living standard (Katipana quoted in the Jakarta Post newspaper in Retnanestri 2007 p154; Dauselt 2009 p17).

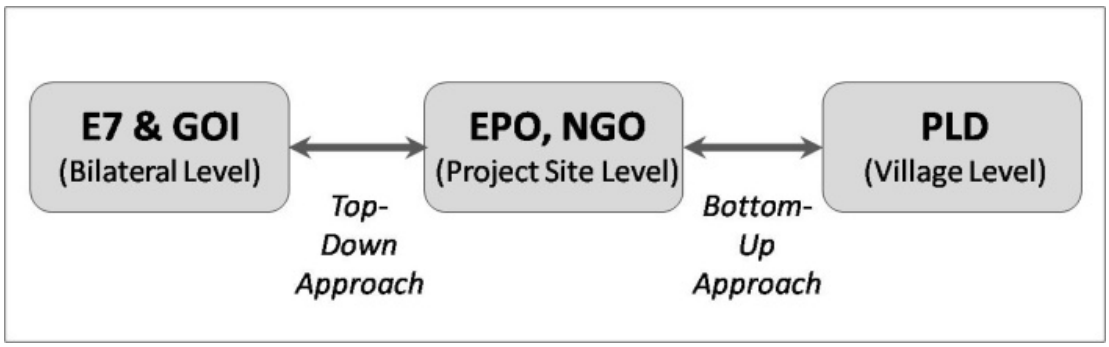

Fig. 3: The E7-PLD project institutional scheme (Retnanestri 2007, p149)

The project included an economic empowerment program that facilitated the formation of local cooperatives to develop and market Oeledo's Palmyra-based handicrafts and fishing. The hybrid system increased Oeledo's per capita monthly income by a factor of 10 from 62,000 Rupiahs (approximately US$ 62) in 1999 to 620,000 Rupiahs in 2007 and the accumulated operating surplus exceeded 120 million rupiahs in 2008 (Dauselt 2009, p17), a significant amount for the village.

Unfortunately the operating surplus had to be spent on, among other things, replacing batteries and paying overseas experts to repair some foreign-sourced components. The PLD chair lady, interviewed in 2005, was concerned that the remaining surplus would not be sufficient to finance future hardware replacement and therefore cheaper stand alone solar home systems (SHS) may be adopted when the present system fails.

From a cultural perspective, the hybrid system was successfully integrated into Oeledo village life. In addition to the per-capita income improvement, villagers enjoyed TV shows in the house of a wealthy family who owned a colour TV and a parabolic antenna, which became a routine social gathering. PLD officers are being considered for promotion in the local government civil service.

The project received a 2000 World Energy Award (Brazil), a 2002 ASEAN Energy Award (Bali) and a 2004 ASEAN Energy Award (Manila). By 2005, visitors from more than 30 countries had visited Oeledo to learn from this rural electrification project.

CULTURAL CAPITAL ASPECTS OF THE PROJECT

The cultural capital aspects of the E7 Oeledo RE project can be summarized as below:

1) *Objectified cultural capital or hardware*: This is the hybrid PV-Wind-Diesel system hardware, which is the trace or realization of the theory and design of hybrid RE systems that is objectified in the PV-Wind-Diesel machinery (Figure 2), as well as the distribution network that connects the PV-Wind-Diesel system to the households and the electrical appliances acquired by the villagers such as lights, TVs, fridges (for ice making) and carpentry equipment.
2) *Embodied cultural capital or software*: This comprises information about the hybrid RE system and the skill and knowledge to operate and maintain the RE system and distribution network and the managerial skill to run the PLD committee (organisation, accounting, management system). This embodied cultural capital was initially held by the project proponent (E7 in this case) and was transferred by Womintra to the Oeledo villagers as the appropriator.
3) *Institutionalized cultural capital or orgware*: The new culture was institutionalized into the Oeledo village through the project organisation structure (Figure 3), including a new institution (PLD) and rules defined and agreed by all stakeholders. Through this "transmission" orgware, the RE technology was acculturated into the Oeledo culture, allowing the Oeledo villagers to harness its services.

DISCUSSION

RE system hardware can be treated as consumer goods if a village already possesses sufficient embodied cultural capital to allow villagers to operate and maintain the equipment and continue to access RE services. This situation can be likened to Bourdieu's narratives on "hereditary transmission" (Bourdieu 1986, p49) of cultural capital or cultural capital previously invested to provide a head start for further reproduction or enrichment.

Where there is insufficient RE embodied cultural capital, 'dumping' RE hardware in an off-grid village (such as deploying RE in a short-term project focusing primarily on the hardware) may result in the hardware being abandoned as a 'white elephant', an 'artefact' that remains alien to the village culture.

The sceptical initial response of the Oeledo villagers towards the idea of generating electricity from sunlight and wind indicated that the village did not possess RE technology cultural capital prior to project commencement. The villagers were also unfamiliar with the idea of a PLD to manage village electricity supply. Thus the whole construct of hybrid system hardware, software and orgware was new to the Oeledo community. Therefore, for the Oeledo villagers to fully appropriate the RE system, they needed to access its embodied cultural capital prior to hardware installation. The process of transferring cultural capital entailed investment in time and effort from both the provider (E7 and Womintra, the initial holders of this cultural capital) and the Oeledo community (the appropriator).

The transfer effort can be summarized as follows:

- *Provider (E7 and Womintra)* stationed field officers in the village for up to two years to familiarize the community with the proposed project, facilitate the establishment of the PLD and provide technical and management training. This significant investment was required because the embodied cultural capital of the RE system cannot be transmitted quickly. It takes "a labour of ... assimilation" (Bourdieu 1986, p48) and sufficient time to acculturate the alien technology, "into a habitus" (Bourdieu 1986, p48). The acculturation period must be sufficiently long to identify and solve problems arising from the differing interests of community members (for example differences in ethnic background, social status, gender issues, etc).

- *Appropriator (the Oeledo community)* needed to be personally involved because the embodiment process cannot take place at second hand. The community was involved in technical and managerial training and in decision-making through village workshops, focus group discussions and neighbourhood discussions. These are "personal" first hand efforts to incorporate the new RE hybrid culture into a local "habitus". This participation is important to facilitate a sense of ownership of the new cultural capital.

The project orgware model combined technology transfer and capacity building with a careful combination of top-down and bottom-up approaches. It provided an effective means of transferring the embodied cultural capital from the initial holders to the appropriator. The project design also prioritized orgware and software over hardware. Deployment of RE hardware is relatively straightforward. However, successful ongoing operation requires the mastery of RE skill (software) and the presence of a local capable agent and or institution (orgware) to maintain RE service continuity throughout the technical lifetime of the hardware.

Trained personnel with their embodied cultural capital become part of the village's cultural assets. This highlights the importance of avoiding the so-called dropout syndrome because if trained technicians leave their posts, continuing operation of the hardware (hybrid power plant) may be placed at risk if they are the only holders of the hybrid embodied cultural capital in the village.

The dropout syndrome can be viewed as leakage of accumulated cultural capital. Thus it is strategically important for the village to nominate trainee technicians who can be expected to remain committed to the village. Obviously it is important to provide these new holders of embodied cultural capital with incentives to stay, safeguarding the village's new cultural asset.

Fieldwork revealed that the village community respected PLD officials, demonstrating that apart from the new job and salary, the officials have gained new social status. Bourdieu explained this phenomenon as fungibility of the various capitals as discussed earlier. Cultural capital, institutionalized in the forms of academic qualifications, is convertible into economic capital under certain conditions. The new skills and knowledge (embodied cultural capital) held by the PLD officials can be considered to be an academic qualification, which can be converted into economic capital in the form of salary. Similarly, social capital, institutionalized in the form of title or nobility, is convertible into economic capital under certain conditions. The new embodied cultural capital held by the PLD officials, on top of the income earned, gave them new social status in the village as well as improved prospects for promotion in the government civil service, which can be referred to as a form of title or nobility.

Thus, the RE system, in the form of hardware, software and orgware, has brought economic, cultural and social capital, the fungibility of which has added to the village's wealth. In addition, the awards and international recognition given to the Oeledo project are a form of title or nobility earned by the community as a whole.

This year (2011) marked the twelfth anniversary of the installation of the Oeledo RE system. However, the long-term sustainability of the Oeledo project remains uncertain. Financial sustainability has not yet been attained, as operating surpluses are insufficient to fund replacement of the system hardware at the end of its technical life. For example, the PLD managed to self-fund five new battery units in 2006 after 6 years' operation (Amalo 2010, p9). However, in 2008, external funding by the E8 and the NTT Provincial governments was required to replace the rest of the batteries (120 units) and

malfunctioning diesel engine components. Also, substantial funds were expended in bringing an overseas expert to repair faulty imported components (this can be seen as a leakage of economic capital that could be reduced by minimizing the use of imported components). The chair of the Oeledo PLD now envisions future electricity supply using cheaper, Indonesian Solar Home Systems (SHS). This demonstrates that the village has inherited a RE cultural capital legacy from the RE project that can provide the village with greater autonomy for future RE projects.

CONCLUSIONS

This paper has shown how the concept of cultural capital can illuminate the issue of RE technology transfer. The analysis focused on the transmission of cultural capital making use of parallels between Bourdieu's concepts of objectified, embodied and institutionalized cultural capitals and Dobrov's concept of technology as hardware, software and orgware.

The E7 Oeledo project is an example of the introduction of RE technology into an off-grid culture. The approach adopted was a calculated embodiment of the RE hybrid system as cultural capital rather than as hardware (machines) alone. The coordinated, joint investment of time and resources by the initial possessor (E7 and Womintra) and the appropriator (Oeledo community) was key to the successful transmission of cultural capital in this project.

This example suggests that for off-grid communities with no prior knowledge of RE technology (an absence of relevant cultural capital), all stakeholders should jointly invest in both time and resources, with a focus on orgware and software, to ensure a successful project. This emphasises the importance of carefully designed project implementation (Retnanestri, 2007).

To sum up, the analysis provides insights into the challenges of introducing RE technology as a novel artefact in off-grid areas and suggests ways to overcome those challenges by:

1) Treating RE technology as cultural capital rather than consumer goods.

2) Understanding the hardware (objectified), software (embodied) and orgware (institutionalized) dimensions of the RE technology.

3) Properly transmitting the cultural capital from the initial possessor (project provider) to the appropriator (recipients) of the cultural capital by understanding the extent of coordinated, joint investment (time and resources) required.

4) Properly designing measures to prevent leakage of the appropriated cultural capital from the village.

5) Understanding local culture and the extent to which RE technology can integrate into and add wealth to off-grid villages by providing them with new cultural capital. Role of facilitator familiar with local culture is crucial to facilitate the blending of new and pre-existing cultures.

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