



LIGHT UP OECUSSE

IMPACT ASSESSMENT

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Executive Summary

This impact assessment of d.light solar lights was conducted in Oecusse enclave, Timor-Leste, from May to July 2013. It has been found that the distribution of d.lights in off-the-grid villages in what is Timor-Leste's poorest and most isolated district is an extremely worthwhile initiative. D.lights offer many immediate benefits in terms of light quality, thus enhancing the activities that take place under them, including work in the home, agricultural labor in the fields, foraging on the tidal flats, and running businesses from home. They also usher in a series of positive flow-on effects resulting primarily from considerable savings due to reduction or elimination of kerosene purchases, savings that range from 15 percent to 50 percent of disposable income. Despite some concerns about d.light battery life and reparability, these are relatively minor in the mind of those that own d.lights. Local users clearly recognise the superiority of d.lights over the existing lighting configuration of kerosene lamps, torches and candles, hence they are highly coveted. Supply has not been able to keep pace with demand, therefore an intensified distribution of d.lights for the district is recommended.

Project Background

Snapshot of Location

Timor-Leste's district enclave of Oecusse lies approximately 80 km from the international border separating contiguous Timor-Leste and west Timor. Oecusse is surrounded by west Timor, except for its north coast, which presents onto the Savu Sea (making Oecusse an exclave rather than an enclave, by definition). Oecusse reaches elevations of up to 1000 meters. It covers some 815 km², and accounts for 15 percent of Timor-Leste's territory.



Oecusse is divided into four sub-districts—Pante Macassar, Oesilo, Nitibe and Passabe—and has a total of 18 villages or *sucos*. The population of Oecusse currently stands at around 70,000 with an estimated 12,000 households. The town of Pante Macassar, with about 5,000 inhabitants, is the economic hub of the district, and for its businesses as well as its position within the paddy rice growing precinct of the central Tono River plain, it is relatively prosperous. Beyond this area, the people rely almost exclusively on subsistence agriculture. Maize, rice, cassava, sweet potato, beans and squash are among the main food crops, and goats, pigs and chickens are raised. Two thirds of Oecusse’s inhabitants have Bali cattle, which allows them to store wealth and acquire disposable income by selling them in times of need. To a lesser degree, pigs fulfill this same role. Those without livestock find themselves in a precarious position, unable to sell an animal to get them through the lean times, in particular the pre-harvest food shortages for which Timor-Leste is well known. Fishing is small-scale, has a subsistence orientation, and is further limited by customary taboos on the consumption of fish.

A recent report by the National Statistics Directorate of the Ministry of Finance, *Timor-Leste Household Income and Expenditure Survey 2011*, found that while nationwide monthly median per capita income hovers around \$40 (\$64 in urban areas and \$32 in

rural Timor-Leste), it reaches only \$24 in Oecusse (all currency references in US dollars). This makes Oecusse the poorest district in Timor-Leste; 61 percent of people spend less than \$1 per day. It also means that bartering remains the most common form of exchange between kinship groups and at local markets, and there is only a marginal level of integration into the cash economy.

Common Practices Related to Technologies

Lack of lighting is the problem. The power grid radiates out asymmetrically from Pante Macassar, and provides electricity to an estimated 2,000 households, generally between 6 pm and 6 am, although interruptions can occur. (During the 2012 national elections, the generators were down for three months). Following the coastal road to the east of Pante Macassar, the power grid reaches the border area of Sakatu, although it barely penetrates inland to a small number of villages flanked by steep mountains. South of Pante Macassar, the grid supplies most villages as far as Tono (about 12 kilometres away). West of Pante Macassar, the grid only reaches mid-way through Lifau, abruptly terminating about one kilometer short of the Tono River, leaving the villages along the lowland strip to the western border village of Citrana (some 35 kilometres away) without grid power, not to mention all of the upland villages.

The great majority of people therefore—an estimated 62,000 or 10,000 households—live off the grid. These people rely on a combination of kerosene lamps, torches and candles for lighting. This comes at a considerable economic cost for lighting that is substandard: kerosene lamps and candles are dim and dirty, and battery torches, due to the cost of batteries, tend only to be switched on for specific tasks rather than for general lighting. Kerosene lamps, moreover, are unusable in windy conditions, so their use is frequently confined to indoors. Both kerosene lamps and candles present a fire risk, and parents hesitate to allow younger children to handle them. They are also known to cause respiratory problems.

Gasoline lamps and generators are not preferred alternatives, given their expense, and so there are few of them. In a small percentage of cases there are low-capacity solar systems with a single panel attached to the rooftop and a battery fitted inside the house. These can provide reasonably good lighting, but most are low quality Chinese systems with a life span of little more than one year; the better systems are more expensive, and only affordable to those few with higher incomes.



These solar systems are generally not long-lasting

Local Partner: Fundasaun Esperansa Enclave Oecusse



Kopernik’s local partner organisation is Fundasaun Esperansa Enclave Oecusse, or FEEO, whose headquarters is in Palaban of Pante Macassar town. This national NGO was founded by Merita de Jesus Marques, the current director, in 2008. FEEO employs ten staff. It runs programs to assist with agriculture, health, environment (eg reforestation), education (eg literacy) and peace-building. The partnership with Kopernik began in October 2010 and continues to the present time.

Project Implementation

The Technology

Three types of durable and portable solar lights, called d.lights, are the subject of this assessment: the S1, S10 and S250 models.

	Type of d.light	Specification	Photo
1.	S1	<ul style="list-style-type: none"> The smallest and cheapest of the three, shedding a narrower light as would a desk lamp or a decent torch. 	

		<ul style="list-style-type: none"> • Has small solar panels built into the unit. 	
2.	S10	<ul style="list-style-type: none"> • Marginally more expensive and casts a broader, more diffuse light. • Has small solar panels built into the unit. 	
3.	S250	<ul style="list-style-type: none"> • Has a small separate panel connected to the light by a removable cable. • Its bright white light illuminates a room equivalent to a 3-5 Watt CFL lamp. • It is significantly brighter than a kerosene lantern. • The S250 features four different brightness settings, providing about four hours of bright light on the highest setting and up to a hundred hours on the low 'bed light' setting. • Can charge a mobile phone. 	

With some technical improvements, these models now have their upgraded counterparts in the S2, S20 and S300 respectively.

Distribution Mechanism, Pricing & Payment

Since the inception of the project in October 2010, d.lights have been distributed over successive phases to groups which form the partner organisation’s own so-called Self-Help Groups (SHGs). In addition, d.lights have been distributed outside the NGO’s direct networks, through other groups (often those of other NGOs or INGOs) whose representatives come to the office to make bulk purchases. D.lights are also sold directly to individuals out of the office at a slightly increased rate. Those who purchase d.lights must do so in the form of a single upfront payment, except in the case of FEEO’s own SHGs, who may spread the purchase across two installments. The repayment price to Kopernik and the standard marked-up sales price to groups are as follows:

Type of light	Repayment price	Standard marked-up sale price
S1	\$6.50	\$7.50
S10	\$7.50	\$8.50
S250	\$12.50	\$15.00

To date, 6,485 d.lights have been distributed in Oecusse enclave. The coastal strip west of Lifau is the most densely populated in d.lights, with a thinner distribution in upland villages. The problem of access, particularly limitations on wet-season travel on the notoriously bad roads, is the main cause of this uneven distribution.

Impact Assessment

Process and Methodology

From 10 May to 15 July 2013, I began with the basic survey format that had been previously used. The surveys sought data on the socioeconomic position of households, the existing lighting configuration, the lighting configuration that preceded the purchase of d.lights, the number of d.lights currently used, and the extent to which, and why, d.lights were valued, positively and negatively. 50 surveys were completed using this format, two thirds of which were conducted by me or in my presence. The sample was

more or less random, but ended up with a cross-section of villages from uplands to lowlands, representing different socioeconomic groups (to the extent possible).

Village Suni-Ufe (upland and lowland subvillages): 29 surveys

Village Taiboco: 7 surveys

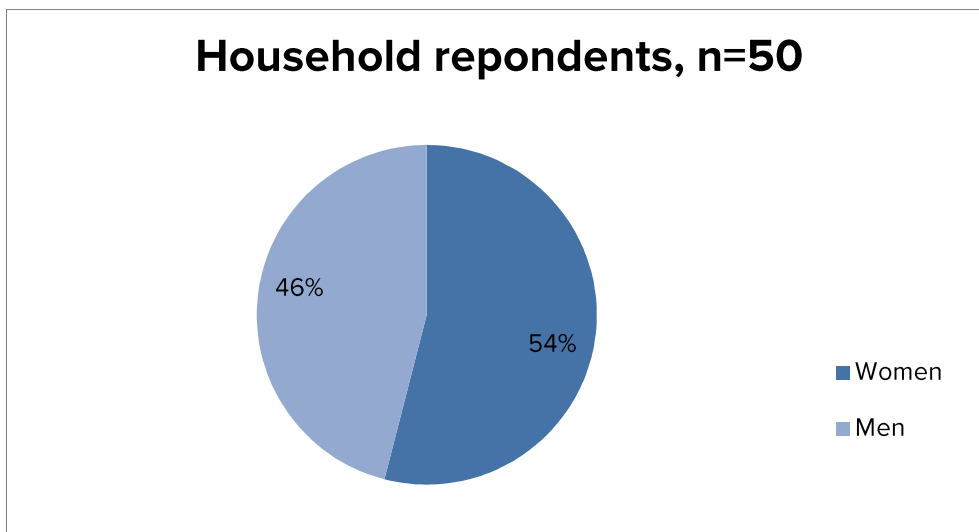
Village Usitahu: 7 surveys

Village Lifau: 3 surveys

Village Abani: 2 surveys

Villages Bobometo, Costa, Coinha, Lele-Ufe: 1 survey in each.

Household respondents comprised 27 women and 23 men.



Household Respondents (n=50)

As the surveying progressed, the limitations of this method became apparent: the method generated too little detail with too much potential inaccuracy, and in some instances encouraged distortions. This was remedied in two main ways. Firstly, in a number of select cases, more detailed information was sought on the economic position of the household in order to complement users' own assessments of household expenditure. Householders' own assessments of expenditure were deemed to provide a rough indication of the socioeconomic position of the household, but they did not give a solid indication of the level of *potential* expenditure, economic security and socioeconomic status of the household. It was thus deemed important to collect data on

the number of livestock held and sold, the possession of wet rice fields, the operation of businesses, and whether any family members were in receipt of a government pension.

Knowledge of these factors offers a broader picture of the socioeconomic standing of the household, which is often reflected in the quality of dwelling and the consumption of rice. The receipt of a pension, available since 2008 to people over 60 years of age as well as to veterans, also alters the socioeconomic position of households in a major way. A new survey sheet was devised to incorporate these and other issues, for possible use in future impact assessments. (The old and new surveys are in the Annex).

Secondly, the survey method as a whole appeared to have certain limitations, particularly given that data were being collected during the day when the lights were being used at night. Nights were the only time when the d.lights could be observed in action. To this end, I undertook a series of six night excursions to the villages and fields to see d.lights. The method consisted of riding in a given direction between 7 pm and 10 pm, stopping to record every d.light use encountered between villages—on the road, in the fields, at or in the river and on the tidal flats. I also dropped in on households in villages, one after another, usually calling out from the front gate until someone appeared, initially surprised if not a little anxious to meet a nocturnal visitor. The method had two main advantages: I could cover considerable distances and see more d.lights in action than I could have had I just spent nights observing one family under their d.lights; discrepancies between how d.lights were *reportedly* being used and how they were *actually* being used thus became evident.

The new method had two main disadvantages: firstly, it did not allow me to get an in-depth appreciation of the nightly rhythms of d.light use in the context of the whole lighting configuration and what might be called ‘the night-time domestic ecology’ linking technology to home practices; secondly, given that ‘people’ known as *ninjas*, dressed in black, are said to be out and about at night, stealing and killing, my sudden appearances could frighten people. I was planning on ten such night-time excursions, but stopped after the sixth.

Limitations of the study

I never had the occasion to witness FEEO’s actual distribution methods directly, since there were no d.lights in stock throughout the period of my stay. This meant, firstly, that

it was impossible to do a 'baseline survey' of those who were about to get d.lights, or at least survey new d.light recipients at a point in time when their old lighting use was still fresh in their mind. I would also have liked to do what might be called a 'qualitative baseline survey': observing households with their existing lighting for one night, and then observing them for a second night with d.lights. This was not possible because no d.lights were available. Only slowly did I realize the potential advantages of building directly on the previous baseline survey, especially given that respondents found it difficult to give any precise indication of how much they had spent on candles and batteries prior to d.light acquisition. The impracticalities of chasing up particular households and persons spread across the district was, however, a significant deterrent.

I should further add that it was disadvantageous to be doing a study of an intervention when a major part of that intervention, namely socialisation and distribution, was not taking place.

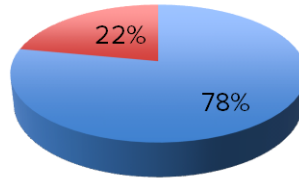
Results of the Impact Assessment

D.lights are excellent! To some degree, however, their impact has been misunderstood due to previously employed survey methods as well as my own. The strength of this assessment is to bring these misunderstandings and methodological deficits to light. Nevertheless, it should be noted that the previous survey for Oecusse, however, was superior to this one in the methodological rigor of the surveying itself, collection of baseline information and the comprehensive processing of data. For the most part, the findings contained in this assessment do not contradict those of previous impact assessments for Oecusse and Ataúro Island.

How d.lights modify the existing lighting configuration

D.lights have been found to decrease or eliminate kerosene purchases, and decrease or eliminate battery purchases for torches. 39 of the 50 households interviewed had eliminated kerosene purchases.

Households which have eliminated kerosene purchases



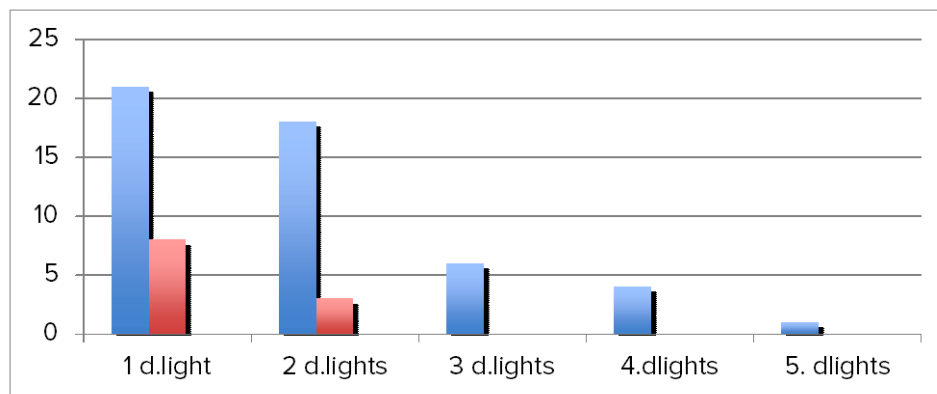
Households which have eliminated kerosene purchases

Note, of the sample:

BLUE –78 percent of households with d.lights have eliminated kerosene use.

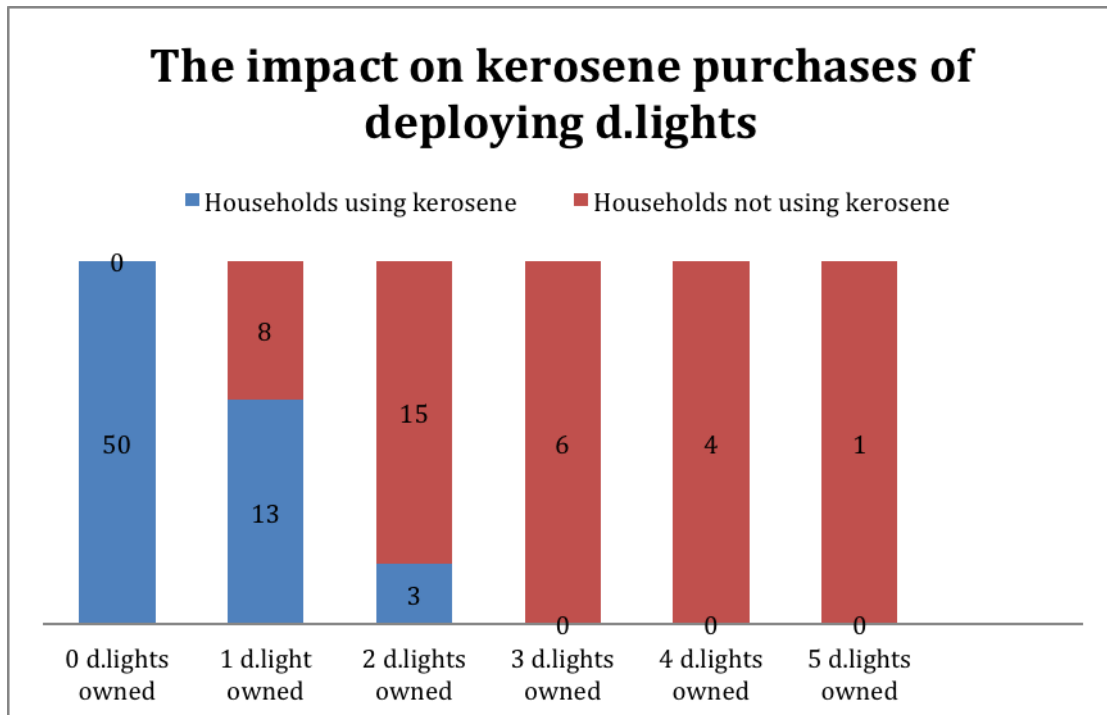
RED – 22 percent of households have decreased kerosene purchases.

Of those which had not eliminated kerosene, eight households had only one d.light and two households had two d.lights. Almost two thirds of households surveyed eliminated kerosene purchases with one d.light, and about five sixths did so with two d.lights. The possession of three d.lights is enough to guarantee the non-use of kerosene lamps; in other words, when a household owned three d.lights, kerosene lamps had been thrown out.



Total Number of d.lights Owned (Blue)

Relative to the Continued Use of Kerosene Fuel for Lighting (Red)



The impact on kerosene purchases

D.lights reduce or eliminate the need for torches, in roughly similar proportions to the kerosene lamps. This is because d.lights are used much as torches are (or were), particularly when more d.lights are available in a given household, in which case one can be 'spared' and taken outside the home precinct.

Candles are not a priority for lighting; at between 35 and 50 cents a packet they are more expensive to use than kerosene lamps, and tend to be brought out as a back-up when no kerosene is available. However, candles remain important, and apparently irreplaceable, for local mass, which takes place regularly under people's verandahs. This, no doubt, is a result of the aesthetic quality of candles and the kind of light they shed. It is also a result of the way spiritual practices are inevitably ritualised, and therefore less flexible.

A generator is very occasionally privately owned (and rented out) or collectively owned. Of the 50 respondents, only one had a working generator (another had a broken one); both households enjoyed monthly incomes of over \$1000, from which we can infer the obvious: this technology is not available to the vast majority. Given generators' high consumption of gasoline, they tend to be used only for important events, such as ceremonies and feasts. D.lights can, and do, complement generators for these festive occasions, and often replace them when no generator is available, which is generally

the case in the remote villages. Of the 50 households surveyed, none had gasoline lamps.

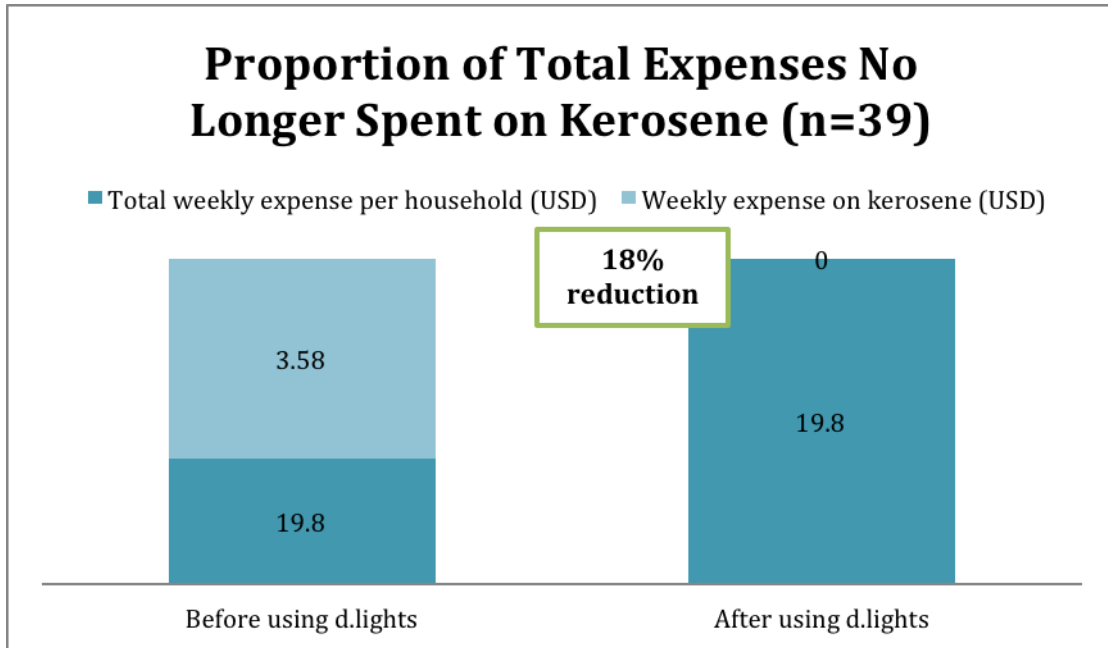
D.lights replace kerosene, torches and, to some extent, candles, just as they can be replaced by, or complemented by, larger solar units or, potentially, the extension of the power grid.

Socioeconomic impact of d.lights due to changes in the lighting configuration

One survey question asked how much people had spent previously on kerosene, batteries and candles. Most answers tended to reflect prior kerosene purchases, excluding details about batteries and candles. This is because kerosene is (or was) procured regularly at weekly markets, in fairly even amounts. Batteries and candles, in contrast, are (or were) procured as the need arises/arose from a local shop. Only a small number of respondents were able to produce what might be considered fairly reliable information of battery and candles purchases, not least because in nearly all cases the interviewees had procured d.lights two years earlier.

Kopernik's 2011 study showed that reductions in kerosene use in Oecusse were in the order of 1.5 to 2 litres per household per week. The present survey puts that figure at just over 3 litres per week; the discrepancy may be explained because a higher number of less poor, lowland households (hence higher kerosene consumers) were represented in the current sample.

Of 39 households who had eliminated kerosene, their total purchases of kerosene were reduced by 122 litres per week, that is 3.1 litres per household. If we take \$1.12 as the average cost of kerosene in Oecusse (it can be much higher in other parts of Timor-Leste), total average weekly expenditure on kerosene is \$3.47 per week per household, equal to \$135.33 across all 39 households. Of the same 39, total weekly expenditure was \$772, which breaks down to an average of \$19.80 per week. Savings from not spending on kerosene therefore amount to an average of 18 percent of present income.



Proportion of expenses no longer use don kerosene

Olga Permanyer Martínez’s [study](#) of d.lights on Ataúro indicates that 66 percent of people who use d.lights on Ataúro, use them as them as their only source of lighting. Notwithstanding continued use of candles in Oecusse for praying, that percentage is slightly higher for Oecusse. The same Ataúro study reveals that the average amount spent each month per household on lighting before owning a d.light was \$11.54; this would seem roughly comparable to Oecusse.

Local perceptions of d.lights and their benefits

In his 2011/2012 impact assessment of d.lights for Ataúro residents, Rob Weis noted that ‘the single most frequent comment from interviewees – often unprompted - was that they wanted to purchase [more solar lanterns](#).’ This is consistent with what I have found in Oecusse. The general perception is that d.lights are high quality and durable. The concerns were minimal and did not seem to alter fundamentally the way d.lights were valued. Across 50 surveys:

- there were five reported cases where batteries needed to be replaced (for \$5 at the office);
- one complained that the S10 battery was quickly ‘bad’;
- two had problems with the cable on the S250 (a dog chomped through one);
- four noted their inability to fix problems relating to S10 switches, although one interviewee countered that there were enough people around who had worked out how to fix them (evidence of this abounded on my travels where I saw tens of S10s with damaged switches, yet still used by joining exposed wires);
- two complained of ‘poor light’ at night when it was not sufficiently sunny to recharge the d.lights during the day.



Faulty switches are easily repaired

None of the above considerations, however, was enough to persuade anybody that d.lights were not far superior to the old lighting arrangement. This, of course, underscores the fact that d.light users are acutely aware of their benefits. (It is interesting to note that I casually offered \$100 to a number of respondents for one of their d.lights, but all refused.) Of the 50 respondents, only two did *not* qualify d.lights as ‘very effective’ and ‘the best’. With one it was not clear why—perhaps he just felt depressed that day. The other to rate d.lights as ‘not very good’ was a man who had purchased a relatively high quality solar system (with one panel on the roof and a sizeable battery inside the dwelling), with which he was very happy. Assessing light is therefore essentially ‘comparative’: there is no objective measure of lighting. (Even moonlight would be rated positively if nothing better was available.)

Subjective measures apply as much to the quality of light itself as to what might be called the evolving ‘narrative complex’ that accompanies the arrival of new technology. It is important to recognize that these narratives are dynamic in relation to technological options and development discourses. [The impact assessment for Ataúro](#), by Olga Permanyer Martínez, proposed that families buying the d.light S250s were mainly interested in the product because they were concerned that their health and their children’s health could be damaged by their prior source of light.

I would suggest that the supposed high concern about nefarious impacts on health impact is: 1) a result of ‘prompting’ and, perhaps more so, 2) a narrative learned through socialisation sessions and, more generally, through institutionalised NGO and state policy discourses. Applied to Oecusse, the socialisation ‘talk’ of FEEO includes information about dirty lighting and negative impacts upon health. Therefore, because baseline studies, both on Ataúro and in Oecusse (2010-11), were conducted after these initial ‘socialisation’ sessions (as far as I can tell), respondents learned these particulars, and then mimicked them. In reference to the present study, it is noteworthy that of the 30 surveys undertaken by me, only three raised health issues.

The aforementioned points to the fact that NGOs, INGOs and state priorities and policies effectively construct the results in the process of ‘defining the problem’ and distributing the technology. As we will see below, this can lead to distortions in understanding the local appropriation of d.lights.

Let us consider the case of the implications of d.lights for childrens’ night-time study or homework. Rob Weis, for Ataúro, notes that most residents were concerned about their children studying by the light of dim and unhealthy kerosene lanterns. A majority of beneficiaries indicated that their children were studying longer and better as compared to previously when fuel was unsafe, dim or intermittently available.

In the follow-up survey of the baseline survey for Oecusse (2011), 43 of 55 households indicated that their children now studied under d.lights, as against 35 in the baseline study. My survey similarly indicated that in 30 out of 50 households children studied under d.lights.

My night-time excursions, however, revealed no children studying with d.lights (except

in the case of an orphanage, where reading materials abound). In addition, casual conversation with more articulate locals revealed the fallacious nature of claims that children outside the principal township of Pante Macassar study, whether under d.lights, kerosene lamps or daylight. ‘The children in the towns study, but not out here in the villages’, confirmed one man. In the case of the first impact assessment on d.lights in Oecusse (2011), it would appear that because the first baseline survey was conducted *after* the socialisation encounters, locals had already learned the ‘narrative complex’, and by the time of the follow-up surveys (between two and four months later) they were even better at it. In my survey, so much time had elapsed since the purchase of d.lights that the ‘study narrative’ required prompting. People doing surveys use prompting to jolt memories, but they are also projecting an expectation of what they believe to be the case. For interviewees, however, prompting is interpreted as a reminder for them to say what they believe they are expected to say or to pronounce ‘the right answer’.

It is yet to be determined how many children in Oecusse’s villages study at night, and whether d.lights have made any difference. The evidence, however, indicates that very few children, if any, do night-time study or, for that matter, daytime study. For a start, very few reading and writing materials are available. Despite this, it would be fair to state that d.lights *would* facilitate much better opportunities for children’s home study, were reading and writing materials available and were the students inclined to use them—my observations of children in the orphanage at Cutete bear this out.



Children studying using the d.light



Children playing cards by d.light

Uses of d.lights

Socializing

In enquiring into specific activities, the surveys also tend to overlook what the d.lights are *most* used for: simple ‘communion’, or being together, often sitting under the verandah rather than inside the house or hut, with children either participating in interaction, playing or sleeping on a mat in the immediate vicinity. In Tetum, this activity is called *tuur de’it*, which we might translate as ‘sitting around’, ‘hanging out’, ‘socialising’ etc. These every-night social occasions are arguably the most important aspect of family and village life, yet they escape description as ‘an activity’.

What Rob Weis in his [Ataúro impact assessment](#) has called ‘evening light in the house’, and has rated as the second most important use of d.lights, can well be put in first place if we examine closely what is going on under this evening light, inside the house and on the verandah. Sitting around at night chatting, smoking and drinking under d.lights must be considered the main ‘activity’ that d.lights light up. All other activities—sifting rice, cutting vegetables, cooking, eating, washing dishes, weaving and others—are embedded in this general night-time rhythm of social communion; people do these things in the presence of others, and that co-presence should be considered important in its own right. What locals call ‘just sitting’, is easily overlooked, as is its critical social

function—that of uniting people, defining family bonds and ‘reproducing culture’. With d.lights, ‘sitting around’ is more likely to occur outside under the verandah than before, as kerosene lamps, like candles, tolerate little air movement.



With d.lights sitting around is more likely to occur outside, because unlike kerosene lamps the wind does not extinguish them

General subsistence-related activities

It is not clear that d.lights are used for fishing in boats at night in Oecusse, as in Ataúro, but they are used for catching fish on tidal flats and rock pools at low tide.



d.lights also serve for catching prawns in rivers or streams.



One informant reported that they came in useful for hunting (birds) after dark. D.lights illuminate certain agricultural activities in the fields, particularly at times of intensive labor input. One example is when the crops are ripening, during which time someone has to stay out in the fields under a shelter (*uma toos*) to keep watch over the fruit or keep pests—animal and human—at bay. Another example, which happened to coincide with my fellowship, is the threshing of rice at harvest time (May to July). It should be emphasized that these threshing sessions are not just evenings spent working, but they are also festive occasions: cooking, eating and playing take place alongside the threshing.



Evidently, d.lights can be so bright [that sunglasses are necessary](#).



A lot more than threshing is going on here

The other main agricultural activity enhanced by d.lights is the tying sheaths of maize together, in preparation for dry maize storage. Like threshing rice, this, called *dulas batar* in Tetum, is also an intensive post-harvest activity that involves the whole family. It is preferably done at night because the sheaths are softer in the cooler night temperatures.



Spot the second d.light in this picture



d.lights also come in useful for corralling the animals for the night, in particular the pigs and chickens



A couple use their d.lights to show me around their sacred house

Additional activities

Weaving to make traditional cloth, mats and baskets is commonly performed by women under d.lights. D.lights are also deployed for night-time activities such as shutting gates, finding out what the dogs are barking at, receiving a visitor, bringing in washing, going to the 'bathroom' (which is invariably in the garden) and so on. If one heads west past Lifau as far as Suni-Ufe along the main road between 7 and 8 pm, one will encounter at least a dozen individuals or groups walking along with d.lights lighting up the path

ahead (about a third will have torches); they may be on their way home from the fields, visiting friends or family, going to mass, drawing water from the well, or off to purchase something at the local shop.



Using d.lights to light up the way when walking at night

In short, whenever a torch is or was used for before, can now be done with a d.light. The d.light not only gives better light than a torch, but there is no rush to turn it off—d.light users well appreciate that recharging d.lights is free.

Security

A night-time excursion from Lifau and past the next couple of villages shows that many d.lights, especially S10s, are hanging on the verandahs well after the residents have disappeared indoors and gone to bed. Some explain this in terms of contributing to a sense of security and, for the same reason, most d.light users leave a d.light switched on all night inside the house.



People in Oecusse are generally afraid of an assortment of witches (*buan*) and evil spirits. Yet they are also worried about intruders and thieves, and terrified of beings (more or less human) known as *ninjas*, who cut off the heads of children to extract their 'vital force' in order to build bridges. Very few people in Oecusse doubt the existence of ninjas. Nor did I after seeing this little ninja (with a d.light); since he thought I was a ninja too (a bigger one), he ran off.



Well, maybe he was too cute to be a ninja, but darkness makes all of us wary

D.lights have other safety implications, some of which are readily apparent to local people, others which are not. The health benefits of using d.lights as opposed to kerosene lamps are appreciable, but this aspect of lighting technology is often not understood by locals. In contrast, the fire risk associated with kerosene lamps and candles, particularly in grass huts, is readily acknowledged, and the safety of d.lights is not lost on anyone. Parents permit their children to handle d.lights without reserve.



A mishap with kerosene reduced this dwelling in Cutete to ashes

Doing business

Those with little shops (*kios*) attached to their homes prefer d.lights for lighting-up these innumerable small-scale enterprises.



Other kinds of businesses, such as motor-bike repair workshops or carpentry operations also use d.lights. There is evidence that in some cases, d.lights allow people to do at night what they would otherwise have to do during the day. A case in point is that of Francisco Ulun (see 'profile of a semi-subsistence household' below) who prefers to make chairs and tables at night, under d.lights, in the cooler night-time air. It appears, however, that in Ataúro d.lights are more firmly embedded in income-generating activities than they are in Oecusse. What remains to be studied in Oecusse, as elsewhere, is the extent to which d.lights are a significant factor in the very upward mobility of households or, put otherwise, in the passage from subsistence to near-subsistence to semi-subsistence household economies.

Gender

As in other parts of Timor-Leste, Oecusse is strongly patriarchal with clear gender-based roles. Domestic violence is common, possibly endemic, girls are less likely than boys to benefit from education, employment opportunities are far greater for men than for women, there are no female traditional leaders, and women are silenced in public forums. Women are largely confined to the home and the agricultural plots, and they are assigned the tasks of cooking and cleaning, which of course extend into the night. It is

typical for men to work in the fields by day, while women look after the children; when the men return at night, women are expected to have dinner prepared, serving the men who eat and relax. D.lights inevitably become part of this gendered night-scape, where women work more and men work less, and where women relax less and men relax more. I would suggest, rather hypothetically, that d.lights have a number of potentially contradictory effects within this general scenario.

- 1) They benefit disproportionately women, as it is women who are more likely to be working at night.
- 2) They further entrench women's roles, and may increase their night-time labor since certain tasks can be performed more easily under d.lights.
- 3) Night-time labor of men might increase for the same reason, which may or may not reduce women's load.
- 4) Increased women's night-time labor might decrease their day time labor, inasmuch as they may now choose, with better light, to undertake certain activities at night.

FEEO has constructed a certain storyline that d.lights reduce domestic violence because women are better able to perform the night-time tasks assigned to them; men are happier when the women are able to their job well, and are less violent as a result, so the logic goes. It is also said that if a married woman fails in her duty to buy kerosene, she may get a beating from her husband. All of this seems to make sense at an intuitive level (particularly for a social context where violence remains a legitimate way to deal with problem or vent one's frustrations), but it remains to be properly studied in its complexity.



The women generally put the solar lamps out in the sun in the morning. Note that a special stand has been built for these two d.lights.



Few d.lights have reached Citrana, a village at the Indonesian border 40 km west of Pante Macassar (given the state of the roads, I was lucky to reach it myself). Only one of these eight women had a d.light, yet they all wanted one.

Conclusions

D.lights are an excellent technology for the village people of Oecusse who live off the power grid. They modify the lighting configuration by reducing, and generally replacing, kerosene, battery torches and candles. The d.lights themselves are very affordable relative to the high savings—from 15% to 50% of household expenditure—that they enable. These savings free up money that can be spent in ways that impinge on food,

shelter mobility and possibly education. Hence, the flow-on value of d.lights is at least as important as the d.lights themselves.

The benefits of d.lights are not simply economic. Activities previously performed under the relatively poor light of kerosene lamps and candles, can now be performed more effectively or efficiently under better light. These activities include cooking, eating, washing up. D.lights also replace torches for particular tasks, chores and errands in and outside the home, such as putting away the animals, getting water from the well, walking somewhere (eg walking home from the fields or going to the shop). D.lights enhance the value of agricultural labor, particularly at those times of year (eg sowing, harvest and post-harvest) when labor inputs are most intense. Overall, because women tend to work more at night than do men, d.lights benefit women disproportionately.

D.lights do offer better conditions for children to study at night, but it is highly questionable whether they have made an appreciable impact in this respect, certainly not in Oecusse. This is because children tend not to study at home, either at night-time or during the day, and study materials are generally minimal or non-existent. This contradicts what the surveys to date reveal (including mine), for the simple reason that beneficiaries tend to mimic certain policy narratives. That children are not studying more at night does not point to deficiencies in d.light technology, but to engrained social and cultural patterns as well as economic constraints that are not conducive to education. D.lights remove one significant obstacle, that of lighting, but they cannot be expected to solve the problem alone. It is important to resist the temptation of exalting one particular technology as the solution to local problems without looking at the complex interplay of factors and conditions.

D.lights also have impacts that we might refer to as 'affective'. They enhance social communion and sharing just as they make the verandah a more common place to gather after dark. The *affect* of d.lights also impinges on safety and security in a context where fear and insecurity are prevalent. The better the light, the safer and more sheltered people feel from evil spirits, intruders, thieves, *ema fuik* (vagabonds or 'wild people') rapists, murderers and *ninjas*. For this reason, d.lights are usually left on throughout the night. D.lights have other safety implications, some of which are readily apparent to local people, others which are not; the health benefits are considerable, and

the risk of fire, particularly in grass huts, is reduced when kerosene lamps are disposed of.

Recommendations

Supply: There is a supply deficit in Oecusse, amidst very high demand. This has been generating a problem locally known as *hatutan tutan*, where individuals turn up to FEEO, often claiming to represent some group or other, to procure a whole carton of d.lights, and then sell them on at much higher prices, often to people who re-sell them at yet higher prices. Half of the solution lies in a greater and constant supply of d.lights (avoiding chiefs who are liable to look for ways to benefit personally). The other half lies in more considered accounting and distribution management by the partner organisation.

Subsidies: The inflated prices that many have paid for d.lights are an indication that subsidies could well be reduced or removed. While this would appear to make d.lights less affordable to the poorest, this would be mitigated by the fact that the long-term financial gains far outstrip the initial investment, even if that investment is double what it has been under the subsidy regime. In addition, there is substantial anecdotal evidence that people with more means buy d.lights to give to their poorer kin. A greater supply of the cheaper S1s (now S2s) could also soften the impact of subsidy removal.

Surveys: I would recommend that two types of surveys be done. First is the regular baseline and follow-up survey. Second would be a more detailed survey seeking data about the socioeconomic position of the household. In Timor in particular—and the same applies to most of eastern Indonesia and much of Southeast Asia—the possession of animals will reflect rural households' economic security and potential cash availability; other critical factors will be receipt of pensions, remittances, employment and business activity (including sale of produce). This type of analysis will enable the evaluator to demarcate with greater clarity various economic classes that may at first appear to be much the same.

Survey content and participant observation: It is not clear that the survey method is adequate for giving a good indication of how d.lights are used in 'activities'; as we have seen with children's study, it produces distortions. In addition to night-time visits, I would recommend that nights of 'participant observation' be undertaken. For example, the

researcher could spend one night in a given household observing the existing lighting configuration, without d.lights, and a second night in the same household after they have acquired, or been given, d.lights. This could be repeated across six different household types—two subsistence households, two near-subsistence households, and two semi-subsistence households (or some similar set of categories to differentiate socioeconomic standing).

Annex

Case Studies

Three profiles follow: of a subsistence household, of a near-subsistence household, and of a semi-subsistence household. D.lights affect these types of households differently.

Profile of a subsistence household

Domingas Tabatan lives with her two youngest children in the village of Cabana of Suni-Ufe (Foholeten) (subdistrict Nitibe). This is not a coastal roadside village. Although in the first year of Indonesian occupation (1976) the villagers of Cabana were relocated to the coast, where each family was granted a block of land, they were permitted to return to their ancestral lands in 1989, where they have been living ever since. The village consists of a cluster of some 15 grass huts on a hillside, which protrude from the treetops like Chinese hats. A fence, built from a combination of living shrubs and dead branches, encircles the village. Small terraced vegetable gardens lie within the enclosure, between the huts, while the main fields are up to five kilometres from the village in any given direction.

Domingas' husband died at home two years ago from an infection in his leg—there was no transport to bring him to hospital from what is one of the more remote parts of Oecusse, accessible only by four-wheel drive and even then only in the dry season.

Domingas grows food for the family—maize, pigeon pea, cassava, sweet potato and peanut—but has too few animals—one pig and one chicken—to sell. At 50 years of age, she is still too young to receive a government pension (which would quadruple her income). Her annual income of less than \$100 is derived from two sources: she performs basic agricultural labour (particularly weeding) for some of her neighbors for \$2 a day; and she receives a little additional support in cash and kind (e.g. clothing) from her two eldest children, who now work in Pante Macassar. With that little income she buys

supplies such as cooking oil, salt, betel nut, and corn and vegetables (if unavailable from her own garden). She also buys two 25-kilo bags of rice a year, for a total of \$40 (including additional transport costs). Domingas and her children are able to eat rice about three times a week—about 300 grams go into one meal, shared among three. There is no *kios* or shop in the area, so the purchase of these commodities involves a day-long walk to Tono market. There is no money to buy other ‘luxuries’. Theirs is a bare existence indeed.



Around the time her husband passed away, Domingas acquired one S10 d.light for \$10. Like her fellow village folk, Domingas no longer needs to spend \$1 per week for the fuel that used to fill her single kerosene lamp. Domingas echoes the general sentiment of those around her, most of whom also have one d.light, when she reports:

I like the solar lamp because we just buy it once and then there are no more costs, we don't have to buy kerosene, and we have light until morning. We don't sit in the dark anymore.

When Domingas mentions ‘the dark’, she is referring to the *relative* darkness that the dim kerosene lamp did little to improve. In terms of light quality, Domingas rates the d.light as ‘very effective’. Yet her primary concern lies with the economic savings afforded by the d.light, which are in the order of \$50 a year; these savings more than cover the cost of rice, which continues to be a major part of her family's sustenance. Rice, not kerosene, is now her single largest expense. For someone whose net income

has been, since her husband died, only twice that figure, it is understandable that the d.light is one of her most cherished items.

Profile of a near-subsistence household

This profile of a *near-subsistence* household is that of Senhor and Senhora Taiboco, whose surname is the same as that of the village they live in—Tai Boco. Their house lies on the main road 15 km west of Pante Macassar, in the coastal sub-village of Makelab. Their house is constructed of concrete bricks. This, however, does not signal much in the way of this family's upward mobility, as the house was abandoned by an Indonesian family in 1999, and subsequently occupied by the Taibocos. Nevertheless, their lot is noticeably better than that of many of the upland, non-roadside communities, hence it is useful to draw a line between subsistence and near-subsistence households, with the Taiboco family belonging to the latter category for reasons that I will explain below.

The household consists of of Senhor Quintiliano and his wife Flaviela, their five children, and two close relatives. They produce maize for their own consumption, as well as small quantities of taro, cassava and beans. They keep a few buffalo, pigs and chickens. Quintiliano receives a pension from the state equal to \$360 per annum. The Taibocos sell, on average, one buffalo and one piglet a year, which brings in \$300. Their annual income is therefore in the order of \$700. With that, they purchase one vegetable type (a leafy green known as *modo*), cooking oil, imported noodles, salt and MSG, garlic, sardines, tobacco, betel nut and alcohol. When theirs isn't ripe or when the season has not been a good one, they must supplement their own maize production by purchasing it at the market. They also buy other farm tools, building supplies, household items, clothes, and prepaid credit for mobile phones. There is no money leftover. In times of need or shortages, an extra cow may be sold; livestock is their equivalent of money in the bank, and decisions to sell an extra animal are not taken lightly.

The Taiboco family bought one S10 d.light for \$8 when they first became available through FEEO. They subsequently purchased two more for \$10, at which point they eliminated kerosene purchases, which had been about five liters per week (current price is \$1 per liter). More recently, they acquired two more S10s, also at \$10 each, and no longer require torches. The five d.lights move back and forth between the roadside brick house and the family farm (where the old grass hut is), which is one kilometre away.



I calculated their monthly savings at \$22 for kerosene and, as a conservative estimate, \$5 a month for batteries and candles; hence \$27 per month or \$324 a year. Assuming a life span of three years for the S10 (which is also conservative), the annual cost of having five S10 d.lights is \$16. Their savings are in the order of \$308 a year for a family whose total annual income is around \$700, but may be up to \$1,000 in the occasional year if a couple of extra animals are sold. D.lights do not increase income, of course, but they generate savings whose effect is as if there were, in the case of the Taibacos, a \$308 annual increase in income. Seen in these terms, d.lights have led to a 30% to 40% rise in disposable income. (If you are currently on a yearly wage of \$60,000, it would be equal to a wage rise of at least \$20,000!).

One difference between a subsistence and a near-subsistence household is that a subsistence household cannot afford rice most of the time, while a near-subsistence household can. The Taiboco household currently consumes two 25-kilogram bags of rice per month, which costs \$18 a bag, eating rice at least every other day and alternating with maize. Annual outlay for rice is therefore around \$220. Before the d.lights, the Taiboco family was able to afford rice some of the time, but not all of the time. 'Sometimes we didn't have enough money for rice, but now we do', observes Quintiliano happily. Quintiliano does not recall exactly how much rice they used to buy compared to now, but if it was one bag per month (which is common for a subsistence household), the immediate consequence of the d.lights has been to double rice consumption, at a cost of \$110 per year.

In Timor, as everywhere, there is a hierarchy of needs and a given, although shifting, set of priorities. Rice is the number one food commodity, followed by maize. When rice appetites are satiated, the next food commodity in line is maize, after which comes *modo* or a green leafy vegetables. *Modo* is often missing in the Timorese diet of a subsistence household, unless it happens to be in season, growing on their own farm. The Taibocos generally grow enough maize to meet their own needs. Now it is in the financial position to supplement maize when it needs to as well as eat *modo* with most meals. For coastal dwellers, the next food in line, after *modo*, is fish; while bigger fish remain unaffordable to the Taibocos, they are now able to enjoy sardines once a week, at a cost of \$2. Each household member will have two sardines dished up.

A doubling of household rice consumption, a relatively constant ingestion of maize and *modo*, plus the weekly delicacy of sardines is enough to account for the \$300 that the d.lights have made available. The Taiboco family is hardly unique. In Oecusse alone there are thousands of such families, and hundreds of families have already benefited from d.lights as the Taiboco family has done. I would say, with no exaggeration, that this is the easiest and most cost-effective way of raising disposable income by at least 30 percent for families that fall within the range of the near-subsistence household *without increasing household labor inputs*, as most agricultural projects do which seek, oftentimes in vain, to turn subsistence farmers into market-oriented producers.

Profile of a semi-subsistence household

For most of Timor-Leste's ethnic groups, a woman who marries will take up residence in the village of her new husband. Although this traditional arrangement generally applies to the Vaiqueno (Meto-speakers) of Oecusse, it did not apply to Francisco Ulan. When Francisco married, he migrated from his isolated upland village to the relatively busy lowland village of Suni-Ufe, where his wife, Filomena, had been raised. In settling next door to Filomena's parents, the new couple broke with tradition for one reason: Suni-Ufe offered economic possibilities that Francisco's upland village did not. For someone as industrious as Francisco, the coastal strip with its main road to the district capital, Pante Macassar, represented an ideal site for setting up a business. As it happened, the newly wed couple set up *three* businesses, with the help of a local micro-credit scheme: they now manage a small store that sells groceries; they run a motor-bike repair workshop; and more recently Francisco makes tables and chairs for schools.

The income derived from these non-subsistence farming activities has gradually grown from nothing in 2010 to its current level of approximately \$2,000. The ‘cash economy’ now provides for half of the family’s needs. The other half comes from the familiar subsistence farming, such that they rarely need to buy food except for their fortnightly 25-kilo bag of rice. They have a few cows, around 20 pigs and just as many chickens, and the intermittent sale of an animal brings in up to an additional \$1,000 every year. Their total annual income, therefore, is now in the range of \$3,000—10 times more than subsistence-only farmers.

The Ulan couple has one child so far, but if they subscribe to the average for Timor-Leste they will eventually have seven or eight! Francisco has two younger siblings who have come to live with them so they can attend the nearby school. By Suni-Ufe standards, Francisco and Filomena are able to live the good life of a semi-subsistence village household: they have a motorbike, a mobile phone, a guitar, and a mattress; their grass hut will soon be knocked down and replaced by a brick house.

The acquisition of three d.lights—one S1, one S10 and one S250—in 2010 set the Ulan family back a mere \$30. I met Francisco for the first time one evening when my motorbike tyre was punctured not far from his repair shop. As he replaced the tube under the glow of two d.lights, Francisco exclaimed contentedly that ‘these save me \$1,000 a year.’ When I returned to meet him a few weeks later, we sat down together and explored his economic situation in more detail. Finally, we arrived at a more realistic figure: the Ulan family saved \$400 in kerosene purchases and batteries a year; his earlier estimate of \$1,000, however, seemed to reflect more accurately his enthusiastic embrace of this reliable and highly affordable solar technology.

But what do we mean when we say ‘saved’? In Timor, savings do not accrue in bank accounts, but are always converted into another commodity or exchange item. In the case of subsistence households, savings made through d.lights tend to manifest directly in levels and frequency of rice consumption. For near-subsistence households, such as the Taibocos, we saw that d.lights allow for an increase in rice purchases as well as a number of other basic foods and commodities. In the Ulan family’s semi-subsistence household, in contrast, the savings achieved from eliminating kerosene expenditure have clearly had a more complex set of effects. To understand this complexity in depth, we would have to compare semi-subsistence households with d.lights to those without

them, and over a long period of time. Such an undertaking lies outside the scope of this impact assessment. However, in the absence of a longitudinal study, what can be said with certainty is that d.lights have been *one critical aspect* of this young family's upward mobility—an important contributing factor in the Ulan family's very transition from a near-subsistence household, as it was in 2010, to a semi-subsistence household, which it is now, with an ever-increasing immersion in the cash economy.



In understanding the role of d.lights and, more broadly, the role of new technologies, in improving life conditions, we have to resist the view that technology alone is what drives social change and progress. As an abundance of research in anthropology shows, technology and society continually reshape each other. In the case of the Ulan family, many things, not only new technologies, have worked to their advantage, not least their entrepreneurial spirit, their willingness to disrupt traditional marriage prescriptions, the availability of micro-credit and the custom that their businesses attract. To appreciate the particular role of d.lights, we have to position the lights within this broad panorama of possibilities, just as we have to position kerosene within the wider panorama of limitations. Without the Ulan's acquisition of d.lights, we might ask, where would the sacrifices have been made to allow them to get to where they are today? Would they have eaten less rice? Would they have sold more pigs? Would they have two businesses, not three? Would they, perhaps, not be where they are today at all, but rather a notch or two further down the economic scale?

Surveys

Survey One (Tetum)

Loron:.....

Suco:.....

Aldeia:.....

Naran Kompletu:.....

Tinan hira:.....

Feto/Mane:.....

Ema na'in hira iha uma kain ne'e?:

Oan na'in hira iha uma ne'e?:.....

Ita-nia familia gasta osan hira semana ida?:

Ita-nia familia gasta osan hira fulan ida?:

Metodu	Ahi-oan solar	Ahi-oan mina rai	Senter	Lilin	Ahi-oan gas	Jerador ka Listrik
Uza ka lae?						
Iha hira?						
Gosta metodu ne'e ka lae?						
Gosta ka la gasta tansá?						
Kalan kalan uza oras hira?						

Ita-nia familia gasta hira ba mina-rai, lilin, pila?	Semana ida?		Fulan ida?	
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	Atividade 1	Atividade 2	Atividade 3	Atividade 4	Atividade 5	Atividade 6
Kalan-kalan ita-nia familia halo saida? (What does your family do each night?)						
Ema-nain hira halo ne'e? (How many do this?)						
Halo atividade ne'e ba horas hira? (How many hours do you do this for?)						

Ita hanoin ahi-oan solar ne'e efektivu ka lae? (Is the d.light effective?)	Efektivo loos, diak liu (very effective, the best)	Efektivo, diak (effective and good)	Efektivo uitoan de'it (quite effective, not too bad)	Ladun efektivu (not so effective)	La efektivu (ineffective)
Hili ida de'it (choose one)					

Saida maka Ita GOSTA husi ahi-oan solar ne'e?	
Saida maka Ita LA GOSTA husi ahi-oan solar ne'e?	
Oinsá bele hadia ahi-oan solar ne'e?	

English translation

Date:.....

Village:.....

Sub-village:.....

Full name:.....

Age:.....

Sex:.....

How many people live in the house?:

How many children?:.....

What is your weekly expenditure?:

What is your monthly expenditure?:

Method	Solar light	Kerosene lamp	Torch	Candles	Gas lamp	Generator or electricity
Do you use?						
How many?						
Do you like this method?						
Why do you like it or not like it?						
How many hours per night do you use it for?						

How much do you spend on kerosene, batteries and candles	Per week?		Per month?	
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	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6
What does your family do each night?						
How many of you do this?						
How many hours do you do this for?						

Is the d.light effective?	Very effective, the best	Effective and good	Quite effective, not bad	Not so effective	Ineffective, bad
Choose one					

What do you LIKE about the solar lamp?	
What do you NOT LIKE about it?	
How can it be improved?	

Revised Survey (only additional questions listed)

Tetum

Hetan osan oinsa?.....

Bisnis iha?.....

Animal hira? Karau: Fahi:..... Bibi:Manu:.....: Oin-seluk.....

Tinan tinan fa'an animal hira? Karau: Fahi:..... Bibi: Manu:

Natar iha? Fa'an foos hira? Simu pensaun?

Loron-loron gasta hira? Semana-semana gasta hira?

Fulan ida sosa foos hira? Sosa saida tan?.....

Lampu charge hira, sosa horibainhira? S1: S10: S250:

Gosta barak loos. Gosta baibain La gosta

Gosta tansa?1. 2. 3.

Problema saida? Aat ona? Hadia oinsa?.....

Tenki sosa pila foun?Hira?..... Horibainhira?

Presisa lampu tan? Hira/modelu nebe?.....

Tansa?.....

Bele selu too hira ba S250? S10? S1?

Uza lampu charge atu halo saida? Aktividade saida? Horas hira? (Hakerek iha kotuk)

Seidauk iha lampu charge, halo aktividade sira-ne'e nafatin/hanesan, oituan de'it, ka la halo? (Iha kotuk esplika oinsa/tansa?)

Uza too dadeer ka horas hira?Uza S250 atu charge telefoni ka lae?.....

Uza ahi-oan mina rai nafatin?..... Gosta metodu ida-ne'e ka lae?

Problema saida? 1. 2. 3

Gasta hira mina rai semana ida, litru hira? Ohin?..... . Litru hira?

Seidauk iha lampu charge gasta hira? Litru hira?

Uza senter nafatin?

Seidauk lampu charge uza senter?.....

Pila hira semana ida?

Gosta metodu ida ne'e?

Uza generator?.....

Sistema solar iha uma leten?..... Lampu gas ka lae?.....

Metodu oin seluk? (hakerek dadus iha kotuk).

Translation of survey into English (additions only):

Money sources?..... Business activities?.....

No. of animals? Cow/buffalo: Pig:..... Goat:Chickens:.....

How many animals sold each year? Cow: Pig:..... Goat: Chickens:..

Rice paddy? Sale of rice? Receive pension?

Daily expenses? Weekly expenses?

Rice purchases per month?

Other purchases?.....

Telephone credit purchases?

Number of d.lights/year of purchase? S1: S10: S250:

Like very much. OK/not bad Don't like

Reasons for liking?1. 2. 3.

Problems with d.lights? Broken? Fixable and how?.....

Battery replacements?How many?..... When?

Need more d.lights? How many/which models?..... For what purposes?.....

How much can you afford for a S250? For a S10? For a S1?

What do you use d.lights for? Which activities? How many hours? (Write on reverse side)

Before you had d.lights, which activities did you do in the same way, not in the same way, or not at all? Explain how and why (Write details on reverse side)

Do you leave the d.lights on all night? How long do you use them for, and for which activities?Do you use the S250 to recharge a mobile?.....

Do you still use a kerosene lamp?..... Do you like this method?

What are its drawbacks? 1. 2. 3.

Current weekly expenditure on kerosene? How many litres per week?

And before getting d.lights? How many litres per week?

Do you use a torch? Before d.lights did you use a torch?..... How many batteries do you/did you buy? Do you like this method?

Do you use a generator?..... A solar system of any kind?..... Gas lamps?.....

Any other method? (Give details on reverse side).