Forest Peoples Project

Low-cost solar energy applications for Batwa communities in the Democratic Republic of Congo and Rwanda

A consultation and feasibility study
by
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in collaboration with **CAURWA** (Rwanda) & **PIDP** (DRC)

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Executive summary

The aim of this study is to assist local NGOs in the Democratic Republic of Congo (DRC) and Rwanda to increase the access of Batwa communities to information through identifying low-cost designs and assembly strategies for solar powered radios and radio-cassettes. The study also explored other solar applications that could benefit rural Batwa (electric light and cassette recorders) and Batwa NGOs (solar powered mobile phones).

The study researches the feasibility of local assembly and distribution of low-cost *DIY Solar* technologies by and to Batwa communities. A series of demonstrations and consultations were held with communities and key local stakeholders, which led to the development of a range of *DIY Solar* technologies. These were then demonstrated and evaluated to identify which were most appropriate. An evaluation of local capacity and resources was also carried out, to determine their availability and accessibility in order to assemble and deliver the technologies.

A parallel assessment was also made of whether local assembly would be a viable and sustainable means of supporting the communities. This analysis led to the design of a framework for developing and transferring technology to the communities and four possible strategies.

The findings of this study strongly indicate that local assembly, distribution and/or use of the proposed *DIY Solar* technologies would bring practical benefits and opportunities to Batwa communities and their support NGOs. The assembly and distribution of these low-cost systems can create income-generating and capacity building opportunities for NGO staff, small community enterprises and enterprising individuals within Batwa communities, increase the organisational effectiveness of NGOs and provide direct benefits to the Batwa communities themselves. Batwa communities would benefit most through access to radio-cassette recorder-players and a self-sufficient solar power supply. Secondary benefits are also likely to stem from the strengthening and cohesive influence that collective use of solar powered radio-cassettes has within communities.

The Author
Since the late 1990s, project consultant Leo Blyth has worked in Kenya, Uganda and Tanzania to refine BioDesign's *DIY Solar* techniques and technologies into a complete package of assistance. Leo has formed the non-profit organisation 'Sunshine Solutions' to source and supply basic *DIY Solar* assembly materials and run capacity-building training workshops covering assembly techniques, product development and marketing, so that local artisans can establish their own *DIY Solar* enterprises. This approach builds on peoples' existing craft and sales skills and provides income-generating opportunities for the producers and sellers of solar technologies. The end-users obtain previously unavailable supplies of safe, clean, and money-saving solar electricity, under their own control, that they can use to meet energy and development needs.

Acknowledgements
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1 Project background

The Batwa NGO, Programme d'Intégration et de Développement du Peuple pygmée au Kivu (PIDP), in the DRC approached the Forest Peoples Project (FPP) for information about low-cost DIY (Photovoltaic – PV) solar technology and technical support to develop projects with Batwa communities living on the edges of the Kahuzi-Biega National Park in south Kivu[1]. This request followed field trials of basic DIY technologies that were supplied by BioDesign[2].

PIDP produces a weekly radio programme but the impacts of this on Batwa communities are limited as very few Batwa households have a radio, and buying batteries is virtually impossible because of their cost. PIDP proposed that the provision of low-cost solar powered radios would increase these communities' access to information, and reduce the cost of buying batteries and environmental damage from battery disposal. There was also the suggestion that low-cost solar lighting could improve Batwa living conditions.

In Rwanda the national Batwa NGO, Communauté des Autochtones Rwandais (CAURWA), also requested information about the technology and its applications for Batwa communities in their country. CAURWA is interested in possible income-generation through cottage-industry assembly of solar-powered devices.

1.1 Low-cost *DIY Solar technologies*

In the context of this study '*DIY Solar technologies*' refers to all locally assembled PV solar modules, battery packs and small electric torches or lanterns. The *DIY Solar* approach is an alternative way to make low-cost solar technologies available in 'sun-rich' Less Developed Countries (LDCs), by enabling individuals or organisations to design, assemble and market low-cost, small and simple solar technologies in order to satisfy various local demands for affordable electricity. In practice the assembly of *DIY Solar technologies* relies on the use of a few, standard and easy to learn DIY techniques.

The process of transferring the *DIY Solar* technology to poor communities for their own development involves:

1. Training the producers and sellers/promoters of the technologies;
2. Establishing enterprises to assemble the products; and
3. Organising distribution networks to channel *DIY Solar* materials to assembly agents and to deliver finished *DIY Solar* technologies to end-users.

2 Project framework and methodology

2.1 Aims and objectives

The objectives and activities of the project are shown in Table 1.

[1] The situation of these communities is described in FPP's publication "Heading for Extinction? Indigenous Rights in Africa: The case of the Twa of the Kahuzi-Biega National Park, Democratic Republic of Congo" by Albert Kwokwo Barume 2000. Published by FPP and IWGIA.

[2] Through years of innovation Graham Knight, founder of the UK non-profit organisation BioDesign, has developed various 'Do-It-Yourself' (DIY) techniques for the low-cost assembly of small and simple solar technologies, such as solar panels, battery packs and low energy consumption lights. Since the mid 1990s BioDesign has encouraged individuals and organisations in LDCs to adopt and popularise these *DIY Solar* techniques to bring low-cost solar electricity to rural populations, who live without mains electricity and with very little money.

Objectives	Activities
Inform Batwa communities and NGOs about ***DIY Solar*** technologies, and the potential uses in community development activities	Demonstrate various alternative low-cost ***DIY Solar*** technologies to Batwa NGO staff, local decision-makers & communities.
	Provide basic technical training & experimental local assembly of ***DIY Solar*** technologies.
Identify whether and how ***DIY Solar*** technologies could enhance everyday quality of life and long-term developmental prospects within Batwa communities.	Conduct field visits & community consultations to obtain information on the living conditions, needs, opinions & priorities of targeted Batwa communities.
	Identify criteria to determine which ***DIY Solar*** technologies most meet local community needs.
	Assess local availability of human resources to assemble & provide technical training, maintenance & servicing of solar technologies.
Propose a range of suitable ***DIY Solar*** technologies and define their designs, their functions and the technology transfer process through which they could be made available.	Evaluate the relative merits of all ***DIY Solar*** technologies & identify with project decision-makers the technologies most suitable for meeting needs.
	Evaluate possible income-generating opportunities to benefit Batwa communities through assembly, use & sale of *DIY Solar* technologies.
Suggest appropriate ways of incorporating ***DIY Solar*** technologies in Batwa community development strategies	Assess local institutional, donor & commercial support for promoting ***DIY Solar*** technologies.
	Assist local NGOs to plan future projects based on the consultation findings.

Table 1: Project objectives and activities

2.2 Methodology

This study was investigative, involving technical demonstrations and participative consultations with Batwa communities, NGOs and other local agencies. Demonstrations and consultations were carried out in partnership with CAURWA (Rwanda) and PIDP (DRC), who provided essential translation, transport and general assistance.

2.3 Activity schedule and time frame

Annex 1 contains a detailed activity schedule and time frame.

3 The targeted beneficiaries of the proposed transfer of *DIY Solar* technology

3.1 Profile of the target beneficiaries

Traditional Batwa house – Idjwi Island, DRC

The indigenous Batwa "Pygmy" people live in the Great Lakes region of central Africa. The Batwa constitute a particularly vulnerable and disadvantaged group, and are amongst the poorest of an already impoverished population. As indigenous people, and for the most part former forest-dwelling hunter-gatherers, the Batwa have long been marginalized by the rest of society, and have suffered severe social, economic and political discrimination[3].

The customary rights of the Batwa to their original forest lands are not recognised in written law or Bantu customary law; consequently where the Batwa have been evicted from their forest lands to make way for agriculture projects or wildlife conservation areas, they have become landless squatters on other peoples' lands. The Batwa suffer from poverty and malnutrition, lack of access to

[3] FPP produced the first comprehensive contemporary account of the Twa in Rwanda: *The Twa of Rwanda. Assessment of the situation of the Twa and promotion of Twa rights in post-war Rwanda.* J. Lewis and J. Knight 1995. World Rainforest Movement and IWGIA. Additional information about the Batwa in the Great Lakes region is given in *The Batwa Pygmies of the Great Lakes Region*. J. Lewis 2000. Minority Rights Group International.

information, education and health care, lack of sustainable livelihoods and vulnerability in conflicts between rival ethnic groups of the dominant society.

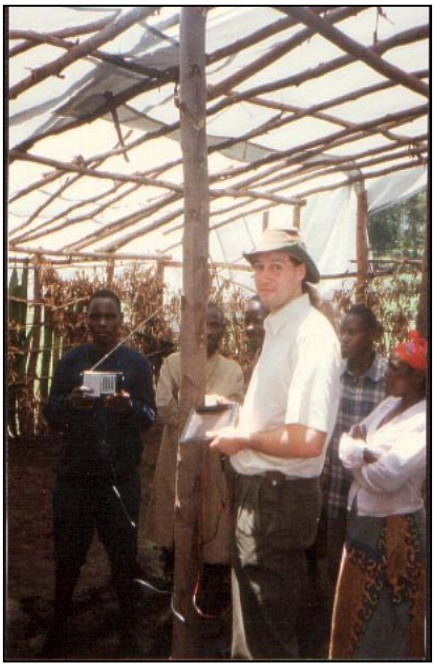
3.2 Summary of demonstrations & consultations

3.2.1 Batwa NGO demonstrations

Demonstrations of the pre-designed technologies were given shortly after arrival to CAURWA (Kigali) and PIDP (DRC). Interest was also shown by the Pottery Project, an initiative being developed by FPP in collaboration with CAURWA to provide capacity building and income generating opportunities to Batwa pottery associations in Rwanda.

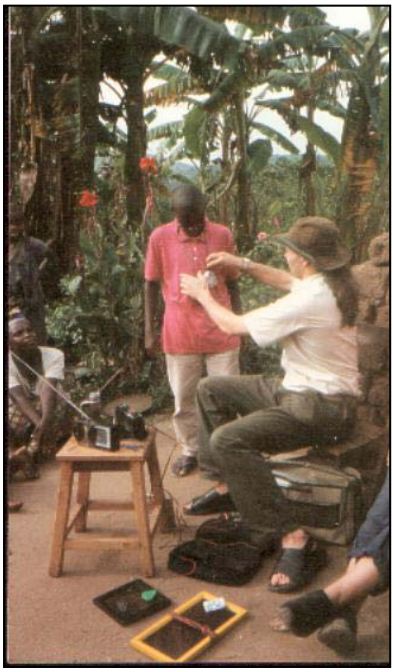
In Bukavu, DRC, demonstrations were also given to representatives from the other Batwa support NGOs – CAMV, AAPDMAC, UEFA and Héritiers de la Justice. The feedback from this meeting and from a subsequent brainstorming session is included in Annex 2, which outlines NGOs' assessments and recommendations of technical design criteria for the *DIY Solar* technologies and organisational advice relating to the establishment of the *DIY Solar* assembly operations.

3.2.2 Batwa community demonstrations



Consultations and demonstrations were carried out with 13 Batwa communities, eight in Kivu province of the DRC, and five in Rwanda. These surveys involved a complete cross-section of Batwa society: children, youths, men, women and elders.

The technologies were shown powering a radio or radio/cassette (which was locally owned whenever available) and specially prepared torches[4].



Solar radio power, from solar module (above left) and from battery pack (above right)

3.2.3 Demonstrations to businesses

Demonstrations were given to several local businesses in Kigali involved in the sale of solar technologies, in order to assess potential commercial interest in sourcing and supplying components, and establishing the local *DIY Solar* assembly enterprises.

None of the businesses was willing to establish local assembly enterprises or interested in taking a pure import role. However all businesses were interested in marketing the finished technologies and it is likely that with more information one local businessman would participate in producing technologies for the commercial market.

[4] Further details of the distribution and use of trial *DIY Solar* Powerpacks to Batwa communities can be found in Annex 3.

3.2.4 Demonstrations to institutions

Demonstrations were given to staff at KIST in Rwanda – the Kigali Institute of Science, Technology and Management. Its founder and vice-rector, Albert Butare, proposed that KIST could assist with the training of local artisans in *DIY Solar* techniques and provide technical assistance to help them establish assembly enterprises.

3.2.5 Demonstrations to others

One non-Batwa NGO was included in the demonstrations and consultations – 'Refugee Trust' which has a country office in Kigali for Rwanda. Independent consultant, Steve Barker, also participated in the demonstrations and strategy meetings due to his familiarity with the *DIY Solar* technique and experience in running local training workshops. Steve was chosen to assemble the Rwandan trial DIY technologies and could be an ideal person to carry out initial training of local trainers and to coordinate the transfer of technology.

4 The needs that *DIY Solar* technologies could meet

Consultations with communities, NGOs and other individuals provided information on the general living conditions of the Batwa and the possible benefits of *DIY Solar* technologies. A summary of these is provided below.

Needs and priorities

- **Experience of well-being**
- Assurance of security
- **Sustainable livelihoods**
- Political representation
- **Access to relevant information**

Constraints

- Low status in overall society
- Poverty
- **Vulnerability**
- Lack of political and cultural representation
- **Poor educational opportunities and access to information**

The provision of electricity supplies could only alleviate a minority of these pressing needs and constraints; however *DIY Solar* technology could impact on those highlighted in bold. These could be met either through powering radio-cassette Information and Communication Technologies (ICTs) and electric light in communities, or through community-based *DIY Solar* assembly enterprises.

4.1 Importance of information in Batwa communities

The need for increased access to information and improved communication was consistently identified as an important issue by all the Batwa communities consulted. However the Batwa have to overcome considerable barriers to access information of any kind:

Educational barriers –Batwa enrolment levels in primary and secondary school are low, and the drop out and adult illiteracy rates are high.

Social marginalisation barriers – School children can be subjected to verbal and physical abuse from other groups. Members of the wider society reportedly ignore, shun or withhold information from Batwa, limiting their access to word-of-mouth information.

Poverty barriers – Batwa poverty limits school attendance and their weak purchasing power restricts direct ownership or access to the various ICTs, including radios, radio cassette recorder-players, televisions, mobile phones, personal computers and global Internet access. Lack of money also restricts the purchase of papers, magazines and books by literate individuals.

Communities emphasised that access to existing radio broadcasts was the most immediate way of obtaining information. Constraints preventing access to this source of information were the lack of radios, cassette players and affordable electricity supplies.

4.2 The role of radios and radio-cassettes in Batwa communities

4.2.1 Appropriateness of radio

Radios use the spoken word, avoiding potential problems of illiteracy, and broadcasts are in languages understood by Batwa communities.

Radios and radio-cassettes are designed to deliver information to a wide audience, which increases their cost-effectiveness. In DRC, PIDP produces a weekly current affairs programme to air Batwa views and convey relevant news to otherwise isolated communities. In this way they are already using radio broadcasts as a two-way means of communicating information from, as well as to, Batwa communities.

Once-weekly live broadcast by PIDP in the DRC

Provided that the initial purchase price and recurrent operating costs can be met, radios and radio-cassettes offer Batwa communities and individuals independence through ownership and control. This promotes self-determination and reduces marginalisation by reducing their dependence on non-Batwa groups for information/communication access.

4.2.2 Community listening groups

Within Batwa communities there is no stigma associated with 'listening in' (which follows from their traditional principle of egalitarianism and practice of sharing resources), and owners provide shared access as a form of public service. In some cases, when there was a broadcast of important public interest, radio owners travelled to neighbouring villages that lacked radios in order to share the news.

The importance attributed to radio information is evident in the self-organised Radio Listening Groups (RLGs) found in every radio-owning Batwa community surveyed, through which people received information regularly and/or on special occasions. Community listening groups were the most common channel of information for Batwa communities, but this channel was easily blocked.

Self-organised radio listening group providing vital links on otherwise isolated Idjwi Island

4.2.3 Limitations of community listening

Although cherished, radios were most often old, in poor condition and the sound quality was not good enough to be clearly audible to a large group of people. Although the cultural obstacles to listening in

did not apply in Batwa communities, it is often not convenient for owners of appliances to make them accessible whenever people want to listen.

Another limitation was that the timing of radio broadcasts was beyond people's control – from their perspective broadcast information simply comes and goes, often in a one-off fashion.

4.2.4 Audio-cassettes: Simple storage of material

The high likelihood of messages not getting through to significant proportions of Batwa community members is thus a major obstacle to communication of information through a community listening approach. However, several communities in both Rwanda and the DRC suggested that radio broadcasts could be recorded for later listening. This could be done by incorporating a cassette-recorder into the radio and provision of cassettes to the owner, assuming his/her willingness to record information when appropriate.

4.2.5 Problems of access to radios, radio-cassettes and power supplies

The survey showed that Batwa communities have a significantly lower level of access to and ownership of radios compared to the general population. During the demonstrations and consultations on average only one–two radios were owned in communities of up to 60 people. In one of the communities in the DRC not even one radio was owned in a community of over 40 people. Only two of the 13 communities surveyed had radio-cassette players and in these communities there was also a greater than average ownership of radios. In all cases the desire for radio access exceeded the actual levels of ownership.

Communities that did not have access to radios and radio-cassettes said that they relied on the tolerance of other communities, usually non-Batwa, to let them listen in to broadcasts of particular interest. However, they reported regularly being ridiculed and feeling under constant threat of being driven away on the whim of the radio owner. The cost of abuse was often considered too great a price to pay for the benefits of access to information.

All the radios and radio-cassettes owned by Batwa communities were powered solely by disposable batteries which meant that owners only use their radios occasionally. When batteries were used up, radio use would be interrupted until the owner had saved enough to replace them. Communities often cited the recurrent cost of batteries as a greater deterrent to buying radios and radio-cassettes than the larger initial cost of buying the appliance.

4.3 Introducing solar powered electric light into Batwa communities

The chief of Bugarula community demonstrates how to plug his people into the sun

The evening light source of most Batwa families is a naked flame – the glow from the evening cooking fire. This is due to lack of money for the regular purchase of candles, let alone investment in a paraffin lamp and buying supplies of paraffin. The naked flames used by Batwa for general lighting are dim, smoky and dangerous, posing fire hazards, health hazards from smoke inhalation and danger of burns to those clustering around the cooking fires.

In the evening, people sleep soon after eating, pausing only to prepare the evening bedding and maybe talk for a while and/or listen to a radio-cassette player in the few households that own them. Batwa stressed that their movements outside the home are restricted at night due to lack of lighting. Generally Batwa do not undertake 'productive' income-generating evening activities and almost all

community members expressed a desire for improved household lighting, as this would have many benefits.

4.4 Implications for intervention

Based on the findings, providing Batwa communities with a simple radio-cassette recorder-player and a *DIY Solar* powerpack would create a direct, reliable and secure channel to radically improve access to information.

In the context of Batwa evening lighting problems, considerable health benefits could result from the introduction of small rechargeable solar torch/powerpacks to assist when carrying out domestic tasks that pose the greatest fire risk, such as preparing for bed, whilst also increasing users' freedom of movement outside the home at night.

Community activities could also benefit from provision of improved lighting. NGO literacy programmes in community-based literacy centres could be easily expanded into the evening. This is feasible through the installation of a small solar system. If accompanied by a radio-cassette player-recorder, community members would have access to information at a time of day when people have finished work and have few alternative activity or entertainment options.

5 Which technologies are appropriate for satisfying Batwa needs?

5.1 Description of technologies

The basic design criteria that emerged from the surveys and consultations were that the '*DIY Solar Powerpack*' (DSP) must be:

- Affordable;
- Reliable and durable; and
- Versatile and user-friendly[5].

Three different DSPs have been identified as suitable for meeting the needs of Batwa communities. The proposed systems and their individual applications are:

Basic DSP – Capable of solar powering small radios and specially made narrow beam torches.
Advanced DSP – Capable of solar powering all radios, cassette recorder-players, mobile phones and the DSP's integral torch.
Universal DSP – Capable of solar powering fluorescent lamps, radios, cassette recorders/players and mobile phones[6].

Each is composed of the following *DIY Solar* technologies:

- A small solar module to generate electricity.
- A rechargeable battery pack to store electricity.
- A specially made torch or in the case of the largest powerpack, a lamp. (Radios and radio-cassettes are available locally).

Each of the three DSPs varies only in terms of its respective electricity generation/storage capacity and general design. All these proposed *DIY Solar* modules and battery packs were fitted with connecting cables and adapters so that they could simply plug into and power a variety of appliances.

DSPs should follow a modular design, which enables the system to be built up piece by piece. Thus, a solar module alone can be used to directly plug into and power a radio (using only the power of the sun), and with the addition of a rechargeable battery pack, solar electricity can be stored.

[5] Further details of the design criteria can be found in Annex 4.
[6] The specifications and performance capacities of each powerpack can be found in Annex 5.

When using a solar module alone, any generated electricity that is not immediately used is lost, whereas if the solar module is plugged into a battery pack any power not immediately used to power an appliance is stored for use when no direct solar power is available, i.e. during overcast days and at night. Using the modular design, the overall electricity generating capacity can be increased by replacing a single solar module with a larger one, or connecting two or more solar modules together. Similarly the electricity storage capacity can also be increased by replacing a battery pack with a larger one or adding more battery packs.

A *DIY Solar* module charging a torch/powerpack and simultaneously powering a radio.

5.2 Community benefits provided by the DIY Solar Powerpack

Table 2 illustrates which needs and constraints each *DIY Solar* Powerpack can satisfy:

TECHNOLOGY MEDIUMS		SYSTEM TYPE			SERVICES DELIVERED	BENEFITS PROVIDED
		Basic	Advanced	Universal		
INFORMATION & CO	**RADIO**	X	X	X	Access to radio broadcasts: = News & current affairs = Developmental programmes = Music & entertainment	**Increased provision of**: **Information** to enhance communities' level of societal inclusiveness, awareness of social/political/economic issues & sense of security. **Education**al material to assist development amongst communities with little or no access to school or adult education facilities. **Recreation**al material for relaxation & enjoyment.
	CASSETTE PLAYER/ RECORDER		X	X	Expanded access to developmental & recreational material. Enhances possibilities for long distance 2-way flows of information.	Increased possibilities for access to developmental & recreational material. Provision of a long distance oral communication channel for communities with low literacy levels & whose characteristic isolation restricts expression of their opinions on issues affecting their welfare & ways of life.

M M U N I C A T I O N	**MOBILE PHONE**		X	X	Provides a direct & immediate means of long-distance 2-way communication.	Provision of a communication channel. under personal/community control. Irrespective of social or geographical isolation this: Facilitates the development &/or maintenance of social relations; Expands business opportunities, enabling long-distance communication for sourcing/selling products & coordinating activities; Increases NGOs' organisational capacity, enhancing channels for internal communication & enabling the reduction of transport costs.
L I G H T I N G	**NARROW ANGLE LOW-POWER TORCH**	X			Providing a narrow beam of light, useful when only a small amount of light is necessary.	Reduction of fire hazards & health risks by enabling night-time domestic activities to be carried out. Facilitating the completion of night-time domestic activities. Enhancement of night-time freedom of movement.
	WIDE ANGLE HIGH-POWER TORCH		X	X	Providing a wide beam of light, enabling a variety of activities that require a focused bright light.	
	FLUORESCENT LAMP			X	All-purpose ambient room lighting offers possibility of communities establishing a night-time 'light house' offering a bright communal space at a time when members are freed from their productive daytime obligations.	Replacement of flame based lighting. Providing a practical & attractive means of lighting a whole room. Facilitating the establishment of an evening time 'community space' to enable the expansion of community activities.

5.3 Evaluation of DIY Solar technologies

The three types of *DIY Solar Powerpacks* were demonstrated and tested. The initial design of the technologies was deemed appropriate by the Batwa and suitable for their use.

In all the community demonstrations the Batwa were interested and excited about getting access to the DIY technologies and the live demonstrations proved a very effective method for quickly and easily explaining the basic principles of how the technologies could be used to generate and store solar electricity for community use.

5.3.1 Power Capacity

The levels of electricity generating and storage capacity required for community use were beyond the smallest basic DSP. Advanced or universal DSP*s* would be required to provide a reliable and adequate power supply capable of consistently meeting typical community power needs throughout the year.

The basic DSP would be suitable for individual household use where only small amounts of power are required and the occasional lack of power can be accommodated. If individual households within a community were to own a basic DSP, they could store the surplus power produced by community solar panels during times of strong sunlight.

5.3.2 Reliability

All technologies composing the DSPs must be composed of good quality components and assembled to a high standard, to guarantee a high level of quality assurance.

5.3.3 Durability

For *DIY Solar* technologies to provide long-term power supplies they must be durable, as well as being technically sound and reliable, as they will be operated in demanding circumstances. In consideration of this all the designs must be robust and the 'packaging' of technologies must be long lasting.

The proposed 'water resistant' design of the solar modules is technically acceptable, as it suits the circumstances in which they would be used within Batwa communities.

When designing DIY technologies, easily damaged moving parts should be avoided where possible and the essential connecting cables, plugs and sockets should be simple and strong.

A basic 'user training' must be provided as an integral element of the technology transfer process and this would further empower Batwa to make sustainable use of the technologies.

5.3.4 Flexibility

Using modular designs and multiple adapters, the technologies are able to provide power in all the situations encountered.

5.3.5 User friendliness

The designs of the various technologies were acceptable and offer straightforward power supplies that need only brief user-training to ensure trouble free operation.

5.3.6 Affordability

The affordability of the technologies is a crucial question. Table 3 shows estimated costs of the different DSPs.

System	Component	Description	Purpose	Materials & costs breakdown for each product line in £*						Total cost for components £*	
				PV plates	Batteries	Light source	cables & adapters	Packaging	Electrical circuitry	Per unit	Total System
Basic	PV Solar module	4v/150mA = 1w free-standing portable PV module with power cable & crocodile clips	Direct power for radio or charging of powerpack	1			1	0.5		**2.5**	**9**
	Battery powerpack	3.6v/320mAh rechargeable battery pack with power in/out socket, 1.5m power cable & multiple adapter	Power for 3–6v radio & LED 'light-plug' torch		2.5		1.5	0.5		**4.5**	
	LED torch	Single white LED directional 'light plug'	Transforms basic powerpack into torch			1.5	0.5			**2**	
Advanced	PV Solar module	7.5v/300mA = 1.5w free-standing portable PV module with power cable & crocodile clips	Direct power for radio, cassette & mobile phone or charging of powerpack	3			1	1		**5**	**14**
	Battery powerpack	6v/850mAh rechargeable torch/battery pack with power in/out socket, 1.5m power cable & multiple adapter	Power for 4.5–12v radio, cassette, mobile phone, & torch		3		1.5	1.5	3	**9**	
Universal	PV Solar module	7.5v/600mA = 3w free-standing portable PV module with power cable & crocodile clips	Direct power for radio, cassette & mobile phone or charging of powerpack	6			2	2		**10**	**27**

	Battery powerpack	6v/4Ah sealed lead-acid battery pack with in/out socket & twin power cables with multiple adapters	Larger storage capacity for the single or simultaneous use of a radio/cassette player, mobile phone, table lamp		5		1.5	1.5	5	**13**	
	Halogen table lamp	Free standing bright Halogen light & reflector	Provides broad beam of light for general lighting			1.5	1	1.5	0	**4**	

*All costs are calculated based upon the wholesale purchase of materials in either the UK, Kenya or Rwanda/DRC. The final costs will depend on the rate of taxes and duties to be paid on imported items.

Affordability was explored in terms of individual ownership and communal ownership:

Private ownership
Only a small minority of the Batwa consulted could afford even the cheapest of the 'low-cost' *DIY Solar* technologies that were demonstrated and individual purchase would mean that other basic needs could not be met.

Community ownership
This study focused on community benefits, because community ownership of DIY technologies will be both an acceptable and effective way of increasing quality of life. The technologies explored in this study are the lowest-cost of all possible electricity generating alternatives that could provide a community with self-reliant power for radios, cassette player-recorders, and light. The whole community would benefit from the provision of one small investment.

It is thus recommended that DIY technologies be introduced as a community resource, with collective responsibility, but also with a specific individual controlling access and operation of the resource. Each targeted community should have an individual trained as a 'Solar Service Provider' (SSP) who would be responsible for making the DSP services available for the benefit of the wider community.

5.4 The benefits to producers of transferring *DIY Solar* technologies

DIY Solar technologies can generate livelihood opportunities for the producers of the technology as well as the end users of the technology.

The straightforward assembly process enables artisans and technicians to swiftly master the *DIY Solar* assembly process through a series of hands-on capacity building workshops. Possession of these strategies, techniques and tools enables local people to set up and run self-sustaining income generating Solar Assembly Enterprises (SAE). The simplicity of the necessary assembly tools and widespread availability of the required local materials makes assembly of technologies possible in even rural locations.

6 Locating the necessary resources for the transfer of DIY Solar technology

6.1 Baseline criteria for local DIY Solar assembly/distribution

Previous *DIY Solar* technology transfer experiences undertaken by Sunshine Solutions in Kenya and Uganda indicate that there are several critical pre-requisites that must be satisfied in order to establish and sustain viable assembly and distribution of DIY technologies. These are:

- Competent and transparent management of the purchase, assembly and distribution of materials and finished technologies.
- Skilled personnel and a work environment conducive to carrying out the DIY assembly.
- Reliable and affordable supply of the required materials.

6.2 Implementation capacity

6.2.1 NGO Commitment

Both CAURWA and PIDP wish to incorporate the delivery of *DIY Solar* technologies within their developmental assistance efforts and are motivated to implement the proposed *DIY Solar* technology transfer project.

6.2.2 Skills/experience and resources

Coordination
Both NGOs have sufficient experience and expertise to be able to coordinate local stakeholders to ensure that the technology transfer is effectively carried out.

Training and maintenance
Both CAURWA and PIDP have extensive links and regular contacts with Batwa communities through networks of rural '*antennes*' and '*animateurs*'. These human resources could provide a network of rural trainers, and trouble-shooters who not only train community based Solar Service providers within communities, but who could also provide information to the NGO administration.

CAURWA has developed a more thorough programme of community based training and is better positioned to carry out basic community based training in the use and maintenance of technologies, and also provide relatively sophisticated community based training in the assembly of *DIY Solar* technologies. PIDP seems to be better positioned to provide centralised assembly training to a cadre of experienced artisans and provide community based training focusing on the use and maintenance of technologies.

Sourcing, storage and supply of components and finished technologies
CAURWA and PIDP have the central management and organisational capacity to provide a central 'hub' for coordinating the supply and storage of *DIY Solar* components in their existing premises. This is already practiced when sourcing, storing and supplying agricultural tools and seeds to assist community agricultural initiatives as well as when providing materials and tools for community tile-making.

6.3 Assembly capacity

6.3.1 Skills

The technical people-based skills that are required to carry out the assembly process are:

- Glass cutting
- Carpentry
- Rudimentary electrical engineering
- Tailoring (optional alternative for producing battery packaging)

In practice the majority of the tasks involved in the assembly of the proposed *DIY Solar* technologies are straightforward and simple to master. Assembling the DIY technologies relies upon practical 'hands-on' work and thus is dependent on human skill-based 'soft technology', rather than tool-based 'hard technology'. Also, as there are different tasks involved in the overall assembly of the technologies, the assembly can be achieved by a team of people with different skills and capacities working together. For example, a carpenter could prepare the frames for the solar modules, an electrician could wire up the battery packs and the actual assembly of the modules and battery packs could be carried out by untrained people who are simply good with their hands and able to pay attention to detail.

These pictures, showing PIDP technicians specialising in carpentry and electrical work (and thereby dividing assembly tasks), were taken during the experimental assembly of trial DIY technologies. The technicians quickly grasped the DIY techniques and, unaided, assembled the solar modules and basic battery pack that will be used for community trials in the DRC.

6.3.2 Materials

Imported materials

Reliable contacts have been established with various suppliers of all the required imported materials in the UK. These materials can be either ordered through BioDesign, which acts as a UK consolidator of all the required DIY materials, or from Sunshine Solutions, which is providing the same service but supplying the materials out of Kenya to serve the East African region. Both these organisations provide this service on a not-for-profit basis.

- Solar plates – The solar cells that make up the finished solar modules are only available through purchase in the UK. Low-cost bulk stocks of these are secured and easily accessible.
- Rechargeable batteries – The rechargeable batteries used in the finished battery packs are available from a wide variety of sources. However, reliable low-cost supplies have been identified from several specialist wholesalers also located in the UK.
- Balance Of Systems (BOS) Components – All the other electrical components and lighting accessories that complement the solar cells and rechargeable batteries in order to make the finished technologies are also widely available. However, low-cost and reliable sources of these have been identified from the same wholesalers as indicated above.

Local materials

The local materials that are used for accompanying the imported materials to produce finished *DIY Solar* technologies are deliberately chosen to be readily available in any large cities with locally-run carpentry, metal work, electrical and glass fitting businesses. The following materials are available in Kigali and Bukavu:

- Solar module framing – Machine-cut wooden timber was found to be the most appropriate material for framing the proposed modules, with plywood used to provide a secondary (protective) layer alongside the solar glass – within the wooden frame. The module is fixed using a variety of glues, sealants and nails or screws and then coated with paint or varnish for finishing.
- Battery packaging – A variety of local packaging materials was available, offering a choice of low-cost packaging options for each proposed battery pack.

6.3.3 Tools

There is no need for either heavy plant machinery or for the import of sophisticated tools. The only large ‘tools’ required are worktables fitted with clamps and vices. Most tools required are available locally and no tools are expensive. Thus initial capital costs for equipment are low. Hand tools are ideal for the majority of assembly and preparation involved and the only tools needing electrical power are soldering irons and (depending upon workshop preferences) possibly power drills. However, the wood used in the solar modules does need to be machine-cut for the purpose. This can easily be carried out as a separate task by paying a nearby sawmill to do the required pre-cutting before bringing the wood sections into the workshop for finishing.

6.3.4 Premises

A large space for operations is only necessary if high volume production is undertaken. A shared workspace would be suitable as long as the following can be ensured:

- Adequate space for both components and finished products to be stored securely and kept in pristine condition.
- Sufficient workspace for preparation and storage of various finished technologies and their component parts.
- Accessible power supplies for specific tasks such as the soldering of electrical components and circuits.

6.3.5 Training and technical assistance

It is essential that initial specialist technical assistance is provided in order to assist local artisans to master the basic techniques required to assemble the DIY technologies and to establish supply lines to source the required materials reliably and economically. A specialist in the DIY technique need only be brought in initially in order to train local trainers who would already be familiar with local technology design and skilled in hand crafts. The author is available to carry out the initial training and suitable local trainers were identified who could incorporate a *DIY Solar* training alongside their existing skills and then be able to provide local technical assistance.

7 Technology transfer

7.1 Context for recommendations

This study proposed the transfer of *DIY Solar* technology to incorporate the technologies into Batwa community development strategies and strengthen local Batwa capacity. The local assembly and distribution of the DIY technologies will be locally managed by PIDP and CAURWA with assistance from FPP. However, it is not recommended that these NGOs undertake everything themselves.

7.2 DIY Solar technology transfer strategies

The transfer into developmental use involves two separate tasks:

1. Establishment of local assembly enterprises and distribution networks and training in *DIY Solar* assembly and use.
2. Sustainable assembly, delivery and end-use of locally assembled DIY technologies by Batwa communities and their representative NGOs.

7.2.1 Assembly & distribution strategies

Batwa communities share the same basic needs and priorities, but differ widely in their abilities to satisfy their respective needs and realize their priorities. Four different assembly and distribution strategies are suggested to meet the different circumstances of the Batwa communities.

The first three strategies are all community-based, each involving a greater level of community participation and organisation that the previous strategy. The final strategy is commercial marketing of the finished DIY technologies.

(i) Complete centralised assembly of finished DIY technologies that are then distributed by NGOs to Batwa communities are available for purchase.

- Suitable for situations in which local *DIY Solar* assembly is inappropriate.
- Suitable for all communities in both Rwanda and the DRC.
- Currently the only recommended option for technology transfer in the DRC.

(ii) Partial centralised assembly. *DIY Solar* components produced centrally then distributed by NGOs to identified Batwa communities for assembly of finished technologies through decentralised local assembly enterprises and for community-based use.

- Suitable for situations in which there is sufficient local capacity.
- Suitable for some communities identified by CAURWA.

(iii) Complete decentralised village assembly and use of DIY technologies. NGOs only source, store and supply materials, and all assembly is in the villages.

- Suitable only in situations where there is a high level of local technical, organisational and managerial capacity within community groups.
- Possible in some communities with higher capacity after they are provided with training and enterprise establishment assistance.

(iv) Commercial sales and marketing of finished technologies at national and local level.

- Suitable only in situations where consumers exist and are able to personally purchase DIY technologies.
- More applicable to non-Batwa with higher and more regular incomes, but possibly suitable for collective purchase by communities.
- Potentially able to provide revenues for assembly enterprises.

7.3 Overall training, monitoring and assessment framework

The following technical and managerial support framework is recommended in order to build local capacity.

- Centralised regional training of trainers (ToT) workshop in Kigali, to impart necessary *DIY Solar* enterprise assembly, management and marketing skills.
- Centralised national meetings of trainers, technical assistants and prospective artisans, in Kigali and Bukavu.
- Series of decentralised local training workshops for trainers and technical assistants to assist the selected artisans in establishing a village-based assembly enterprise.
- Provision of regular monitoring and technical assistance to assembly artisans at local level in all participating communities.
- Organisation of regional workshops to share experience, gather information and feedback for all trainers, artisans and coordinating NGOs.

7.4 Sustainable assembly, delivery and end-use of DIY technologies

7.4.1 Overall strategy

In practice, the conditions in Rwanda and the DRC are sufficiently different to warrant different assembly and distribution strategies for transferring the technology to Batwa communities in the two countries. The Rwandan conditions are more conducive for a decentralised assembly and distribution strategy based on a higher level of community participation in the assembly of technologies. A more appropriate approach in the DRC is to centralise assembly and distribution, with community participation focusing on ownership and maintenance.

The largest demand for *DIY Solar* technologies, and the most varied opportunities for their production seem to be in Rwanda. All the Rwandan communities visited are interested in the technologies, and their participation in other development activities has prepared a foundation for the community use of *DIY Solar*. Rwandan Batwa groups also have a greater capacity to participate in production of the technologies, compared with the Congolese Batwa whose organisational capacity is lower and whose other basic needs are more acute.

Rwanda's capital, Kigali, is a more developed trading center than Bukavu, with easier access to materials, and opportunities for greater savings on bulk material purchases and their redistribution nationally and regionally. Materials can be shipped from Kigali to Bukavu in four hours by road.

The overall recommendation is that materials are centrally sourced, stored and supplied in bulk from a central agency in Kigali (either operated as a commercial offshoot of CAURWA, or jointly managed

by them and a commercial partner), which would serve as the national producer of both finished technologies and national/regional distributor of materials, training and technical assistance to local enterprises in Rwanda and to another national centre in Bukavu/Kivu-DRC. A similar centre should be located in Bukavu and operate in a similar but smaller capacity to coordinate the DRC *DIY Solar* programme.

Decentralized assembly and distribution networks in Rwanda and DRC involving community groups and NGOs could then be established independently, although would aim to incorporate regular experience sharing and solidarity building workshops between the groups.

7.4.2 Country specific strategy – RWANDA

- A central body should be created to coordinate the import of materials and assembly of partially completed and finished *DIY Solar* technologies. This could be the *DIY Solar* headquarters for the region.
- A series of training of trainers workshops would create a trained cadre of decentralized rural outreach extension agents and key community members. This would involve training one of CAURWA's rural based animators and a local village representative, from each of the target communities that CAURWA wishes to include in the *DIY Solar* project.
- These participants would return to their localities with all the resources necessary to get their communities started in the actual assembly of *DIY Solar* systems.
- CAURWA would continue to provide support and monitoring during the implementation of the *DIY Solar* enterprises.

7.4.3 Country specific strategy – DRC

In the current climate, community assembly of *DIY Solar* technologies faces considerable barriers in terms of community capacity, security and infrastructure. However, the technologies should be provided.

- The *DIY Solar* technology transfer should involve centralized assembly of finished technologies through a programme within PIDP, and distribution to communities.
- PIDP has a team of technicians (carpenter and electrician) who are both close at hand and have experience of working with its programmes and one specialist rural technician who has personal experience of both conventional and *DIY Solar* systems, and is involved with PIDP's activities throughout the region. These people are well-positioned to run a centralised assembly enterprise and provide decentralised training in the use of the technologies.
- As community capacity and resources increase community participation in the production process can be expanded.

8 Conclusions

The findings of this report strongly indicate that *DIY Solar* technologies would bring practical benefits and opportunities to Batwa communities and NGOs. The assembly and distribution of these low-cost solar systems can create income generating and capacity building opportunities for NGO staff, small community enterprises and enterprising individuals within Batwa communities; increase the organisational effectiveness of support NGOS and provide direct benefits to the Batwa communities themselves. Batwa communities would benefit most through access to a radio-cassette recorder-player and a self-sufficient solar power supply to improve access to and communication of broadcast and recorded information. Secondary benefits are also likely to stem from the strengthening and cohesive influence that collective use of solar powered radio-cassettes has within communities.

Of three different DSPs demonstrated, the levels of electricity generating and storage capacity required for community use were beyond the smallest basic DSP. Advanced or universal DSP*s* were found to provide a reliable and adequate power supply capable of consistently meeting typical community power needs throughout the year. The basic DSP was more suited for individual household use where only small amounts of power are required and the occasional lack of power could be accommodated.

Both CAURWA and PIDP have extensive links and regular contacts with the communities, through networks of rural '*antennes*' and '*animateurs*'. These human resources could provide a network of rural trainers, and trouble-shooters who not only train community-based Solar Service Providers to give guidance and assistance within communities, but who could also provide expertise and contacts with the NGO administration.

These NGOs have the central management and organisational capacity to implement such a transfer of technology to the communities, and the in-depth local knowledge to select the most suitable Batwa communities for involvement.

The initial training of local artisans could be carried out through a series of regional, national and local workshops. Following these, assembly and distribution could be entirely locally managed, following one of several strategies adapted to the different local capacities and community circumstances that exist.

Annex 1: Activity schedule and time frame

Date (2002)	Activities	Organisation /name/contact	Overview	Outcome	Follow-up
25.02	Transit – arriving in Kigali late afternoon.				
	Introduction to CAURWA aims, activities & staff.				
26.02	Purchase of radios for demonstration applications.	Kigali central market	Wide variety of cheap radios & radio / cassettes available.	Purchase of 10 handheld 3v radios.	Use radios for demonstrations & leave with communities for ongoing trials.
	Purchase of materials for production of Batwa *DIY Solar* modules	Kigali hardware stores	Plywood, sheet plastic & glues purchased from various stores.	Purchase of enough materials to make several samples of very low-cost *DIY Solar* modules.	Assemble very low-cost solar modules for demonstration alongside more expensive low-cost alternatives & gather feedback to identify which design is most appropriate for use in Batwa communities.
	Demonstration of *DIY Solar* technologies to CAURWA staff.	CAURWA	Demonstration & accompanying explanation of assembly process were well received.	High level of interest & optimism about possible integration into activities.	Devise schedule for community demonstrations & consultations.
27.02	Transit from Kigali to Bukavu – Arriving in Bukavu early afternoon.				
	Introduction to PIDP aims, activities & staff.				
	Demonstration of *DIY Solar* technologies to PIDP staff.	PIDP	Demonstration & accompanying explanation of assembly process were well received.	High level of interest & optimism about possible integration into activities.	Devise schedule for community demonstrations & consultations.
28.02	Demonstration of technologies & discussion of possible 'pro-Batwa' applications with local Batwa support NGOs.	CAMV, AAPDMAC, UEFA, Heritiers de la Justice, PIDP	Demonstration & accompanying explanation of assembly process were well received. All NGOs wished to participate in current study – this was unfortunately not possible due to financial & time constraints.	General interest in enabling Batwa communities to use technologies for powering radios. But no clear identification of how to incorporate technologies into current activities.	Schedule further meeting for more in-depth discussion.
	Demonstration of *DIY Solar* technologies & collection of feedback from Batwa community members	Muyange Community in Kabare	Very poor community, expressing varied basic needs – claiming not even a sole radio in village. Meeting held in community literacy centre. Interest in community solar powered radio system.	Clear Indication of high level of poverty, vulnerability, information & communication problems in Batwa communities. Also identification of general positive contribution that a community literacy centre can make.	Donation of DIY technologies for trials once study completed.
1.03	Demonstration of *DIY Solar* technologies & collection of feedback from Batwa community members	Bushulishulie Community in Kalehe	Isolated community with high level of radio-cassette ownership. Radio-listening groups (RLGs) very evident.	Cost of batteries, no access to radios is main cause of low listening rates.	Donation of DIY technologies for trials once study completed.

2.03	Feedback from the PIDP technicians involved in previous trials of sample *DIY Solar* technologies	PIDP	Technicians explain limitations of previous technologies & recommend changes.	Samples were not durable, powerful or easy to use. DIY technologies for regular use must be all this & more.	Incorporate these technical recommendations into design of proposed Batwa DIY technologies.
	Research to assess the availability of local assembly materials	Various building merchants & hardware store in Bukavu.	Information on the availability & costs of all the materials required for the assembly of the DIY technologies.	All the basic required materials were available, but all were significantly more expensive than in Kigali.	Recommend purchase of all materials in Kigali – for Rwandan & DRC assembly of *DIY Solar* technologies
3.03	REST DAY				
4.03	Observation of PIDP radio programme planning meeting & radio station demonstration.	Government run radio station.	Predominantly personal interest in use of DIY technologies.	Professional interest was in larger systems for powering radio booster stations.	Schedule future opportunity to watch the live broadcast of PIDP's weekly Batwa education & news program.
	Research to assess the availability of local assembly materials	Various building merchants & hardware store in Bukavu.	Information on the availability & costs of materials required for the assembly of the DIY technologies.	Visits to large saw -mills confirmed local possibility for sourcing wood for module framing.	Use local wood from sawmills for DIY assembly, as it is not practical to transport from Kigali.
5.03	Planning meeting with PIDP programme manager to prepare schedule for follow-up trip.	PIDP Stephen Ilundu	Discussion identifying possible communities to visit & activities to carry out on return trip.	Tentative schedule of events for return trip.	Confirm schedule before return date.
	Follow-up brainstorming meeting with Bukavu based Batwa support NGOs.	CAMV, AAPDMAC, UEFA, Heritiers de la Justice, PIDP	Discussions identifying possible *DIY Solar* interventions.	Suggestions included in section 4.2.	Incorporation of suggestions into overall report & distribute report to all participants.
6.03	Basic training of PIDP technicians in *DIY Solar* assembly techniques.	PIDP	Presentation of tools & techniques required for assembly of *DIY Solar* modules & battery packs.	The technicians grasped the central concepts & were eager to experiment with the DIY assembly.	Organise & facilitate an experimental assembly workshop for next trip.
	Transit from Bukavu to Kigali – arrival early evening				
7.03	Restricted activities due to national holiday.				
8.03	Meeting with local consultant already involved in *DIY Solar* experiments, with an engineering background & experience as a trainer of trainers.	Steve Barker	Mutual demonstration of DIY technologies, briefing given on nature of study & overview of Steve's expertise is given.	Apparent suitability of Steve providing local technical assistance to any local *DIY Solar* technology transfer project.	Schedule further meeting to discuss possibilities for collaboration.
	Further local materials research.	Various hardware & electrical stores in Kigali town	Wider research identifying the availability of local *DIY Solar* materials & commercial Solar technologies.	Confirmation that a large proportion of the requisite local assembly materials are available. Noted the high local cost of commercial solar technologies.	Purchase materials when necessary. Look into possible local business interest in purchasing low-cost *DIY Solar* technologies.

9.03	Discussion with Pottery Project consultant.	Elaine Gardener FPP/CAURWA Pottery Project	Brief demonstration led to discussions about possible parallels between assisting the establishment of local Batwa *DIY Solar* assembly enterprises & small enterprise management skills & assistance that the Pottery Project is giving to selected Rwandan Batwa associations.	Agreement to investigate how to build the Pottery Projects success into any future *DIY Solar* project & seek means to use the DIY technologies to further uplift the Batwa associations already working with the pottery project.	Give demonstration of *DIY Solar* technologies to Pottery project staff & explore possibilities for collaboration.
	Visit to one of the Kigali based pottery associations working with CAURWA & the Pottery project.	'Asuman' group	Demonstration of Batwa cultural dances & pottery works by group.	Noted that the group needs new premises & the possibility of incorporating *DIY Solar* technologies into the premises.	Maintain contact & develop possibilities for collaboration.
10.03	REST DAY				
11.03	Exchange of radios for alternative models.	Kigali central market	The majority of radios were exchanged for models that were more representative of those found to be owned by Batwa.	A wider variety of radios were made available for incorporation into demonstrations & left behind for trials.	Continue to ensure all appliances used for the study are suitable for end-use by the Batwa.
	Production of trial prototype torch - powerpack based on Batwa feedback	Leo Blythe	Adaptation of basic battery pack design to convert a locally bought torch into a torch/powerpack.	Confirmation that local torches can effectively be converted into rechargeable torch/powerpacks that can power radio/cassettes as well as provide light.	Trial the design in future demonstrations & produce more during study if feedback is favourable.
	Meeting with local 'Solar' businessman	Gabo Wilson	Gabo is involved in a variety of local businesses & has already invested in importing more expensive solar technologies that are selling slowly.	Most interested in participating in any efforts to make low-cost solar technologies more available in the region.	Schedule a further meeting to identify possible business roles that would be needed in the proposed *DIY Solar* project.
12.03	Meeting with staff at the Kigali Institute of Science, Technology & Management (KIST).	Ravikumar Kandasamy KIST	Demonstration of DIY technologies & explanation of proposed technology transfer (TT) project. Identification of future need for local training personnel & training facilities to enable TT.	Introduction to head of the Appropriate Technology department & the head of training both of whom welcome the chance of assisting the proposed DIY project. Ideal location for future *DIY Solar* training workshops.	Schedule further meeting with Ravikumar to look into possibilities.

	Demonstration & meeting with local NGO involved in supplying self-powered radios to vulnerable groups in Rwanda.	Aine Breathreach Country Director Refugee Trust (RT) Rwanda	Demonstration of technologies given & an overview of RTs previous radio programme is received. We also discuss possibilities for the local assembly of *DIY Solar* technologies	Interest in exploring possibilities for RT to incorporate *DIY Solar* activities into their programme & promise to pass on a sample of the radio information packs that are used in their projects.	Send more information on *DIY Solar* & await radio information pack.
13.03	Demonstration of *DIY Solar* technologies & collection of feedback from Batwa community members	Ntenyo Community in Gitarama	Very receptive group, dynamic & clearly well organised production of clay tiles. Emphasis of using radio to hear news. A complete explanation of the technologies was given & group grasped all aspects.	Good example of a well organised group that seems interested & able to incorporate use of DIY technologies into developmental activities. Even interested in buying technologies not just receiving as gifts.	Donation of DIY technologies for trials once study completed. *Good group to take lead in exploring partial community based assembly of DIY technologies.*
		Ruyumba community (Abegesendo association) in Gitarama	Settled group in respectable housing, one particular young boy was the prominent 'radio-owner' – use of radios to access news & education programmes. Demonstration was well understood & again offer made to pay for access to technologies.	Poignant example of boy owning the radio having bought it after dropping out of school due to poverty shows role for radio education & progressive role of the youth. Complete group willingness to share radio & DIY power supplies.	Donation of DIY technologies for trials once study completed. *Possibility of youth being the recipient of training as the community Solar Service Provider & trouble-shooter.*
14.03	Transit from Gitarama to Gikongoro districts & general observations while accompanying CAURWA staff on execution of other project fieldwork.				
15.03	Demonstration of *DIY Solar* technologies & collection of feedback from Batwa community members	Gasaka community (Dufashanye association) in Gikongoro district	Adaptable group, living in temporary houses & yet applying new agricultural techniques. One old radio was owned & cherished for providing valuable access to news & other educational information. Operation of the technologies & even the issue of financing understood.	Very appreciative of being shown the technologies & could see a new way of powering radios that they valued very much. Much information gathered about community radio listening practices & programme preferences.	Donation of DIY technologies for trials once study completed. Self-help efforts clearly indicate the communities' pro-active stance in promoting its own development. Good to work with.
		Nyacondo community (Abishizehamwe association) in Gikongoro district	Group comprised of mainly widows due to the genocide. The demonstration was well received & the radio was very prized in the community to bring in information.	Women spoke of an eagerness to share the use of the technology with their neighbours.	Donation of DIY technologies for trials once study completed.

		Nyaruguru community association in Gikongoro district	Impromptu meeting place in market place where Batwa were begging. The group was visited primarily for distribution of tools to support CAURWAs agricultural activities. Conflicts developed between different groups of Batwa that were gathered in the market area.	Indication of the wide variation in the community cohesion & development of various Batwa communities. Very clear that such groups would not be able to effectively operate a scheme to share access to a solar powered radio within a community.	Monitoring of situation & if improves then consider for possible future inclusion.
16.03	Transit from Gikongoro to Bukavu – arrival early afternoon				
	Purchase of low-cost torches from hardware store.				
	Produce more torch/powerpacks for local trials.	Leo Blyth	Conversion of locally bought torches into torch/ powerpacks.	Plastic torches were used instead of the metal one previously trialled.	Once more gather feedback on torches & incorporate when producing the final batch for Rwandan trials.
17.03	REST DAY				
18.03	Observation of live PIDP broadcast of Batwa educational programme 'Bambuti'.	PIDP	A small group of Batwa had journeyed from their rural village to tell PIDP that they were being persecuted by militia & this was aired on the program.	Very insightful to appreciate how directly the broadcast issues relate to everyday living conditions of the Batwa.	Prepare a *DIY Solar* broadcast informing Batwa about the 'solar radio' possibilities once the project is operational.
	Experimental assembly of battery pack & solar module with PIDP technicians.	PIDP	Work with PIDP carpenter in his workshop (located near the sawmills in Bukavu) & electrical technician to practice DIY assembly.	Very quick grasp of techniques by the technicians. The premises & skills to enable the high-volume assembly of technologies were clearly available.	Test assembly of technologies undertaken by the technicians while consultant & PIDP team visit nearby communities.
	Transit from Bukavu to Idjwi island – arrival early evening				
19.03	Demonstration of *DIY Solar* technologies & collection of feedback from Batwa community members	Kisize community in South Idjwi	Community is making living as landless labourers & collectors of firewood. Community 'own' a literacy centre, which already serves as focal point for listening to PIDP Bambuti broadcast on one person's radio.	Generally Batwa not proactive in promoting own development. However, the literacy centre is already established & is providing education to community. Perceive DIY technologies only as a form of gift aid.	Donation of DIY technologies for trials once study completed. Considering circumstances, community literacy centre is good location for installation of community owned radio/cassette & DIY power supply.

		Buruhka community in North Idjwi	Similar situation as previous community. Low attendance at community literacy centre due to peoples daily search for work. No access to Bambuti broadcasts due to poor reception. Use of radio primarily for news & entertainment. High school attendance but only due to donor sponsorship that is unreliable in the long term.	Striving hard to survive, with little surplus to promote 'development'. As above, they cannot imagine personally purchasing DIY technologies. Very interested in DIY technologies as prohibitively expensive batteries undermine radio use.	Donation of DIY technologies for trials once study completed. Considering circumstances, community literacy centre is good location for installation of community owned radio/cassette & DIY power supply.
20.03	Demonstration of *DIY Solar* technologies & collection of feedback from Batwa community members	Joint meeting with representatives from Buze, Kachuba & Shenge communities in North Idjwi	All attendees at meeting live in small widely dispersed communities. Radios used for accessing all manner of information, from news & education to entertainment. Only occasional gathering for group listening, news typically passed on by word of mouth.	All representatives are interested in using DIY technologies & were used to sharing resources in their impoverished communities. Once more literacy centres provide ideal venues for community listening.	Donation of DIY technologies – to each participating community – for trials once study completed.
21.03	Demonstration of *DIY Solar* technologies & collection of feedback from Batwa community members	Bugarula community in North Idjwi	Well-organised & closely spaced community. Village leader served as guide for all Idjwi visits & clearly identified the wide community use of radios to access all kinds of information.	Highest level of radio ownership (5) in community, out of all groups visited. Few children at school, radio is primary means of accessing information.	Donation of DIY technologies for trials once study completed. No community literacy centre, but many informal radio listening groups have formed.
	Meeting with local Mwami for official notification of activities	Rubenga Gewais Idjwi – Nord Sud Kivu B.P. 162 Bukavu	Record of visits to Idjwi. Discussion about needs for electricity on Idjwi island.	Provision of official stamp recognising activities. Encouragement for introducing DIY technologies amongst Batwa communities.	Advance notification to Mwami before future visits to Idjwi. Request for Mwami assistance when organising future visits to Idjwi.
	Transit from Idjwi island back to Bukavu – arrival late evening				
22.03	Feedback on progress of experimental assembly of technologies undertaken by PIDP technicians.	PIDP	Return visit to PIDP carpentry technicians' workshop & collection of completed *DIY Solar* modules & basic battery packs.	Successful completion of experimental assembly by technicians.	Propose PIDP technicians as willing & able to produce technologies for proposed transfer of *DIY Solar* technologies.

	Planning meeting with PIDP management	PIDP	Feedback to project coordinator & discussion concerning possible follow-ups to feasibility study activities.	Appreciation by project coordinator for study. Agreement that he will oversee distribution of trial technologies to selected communities.	Provide copy of report to PIDP on completion. Consultation with PIDP staff to plan follow-up DIY technology transfer based on report findings.
	Transit from Bukavu to Goma – departure early evening				
23.03	Transit from Bukavu to Goma – arrival early morning				
	Visit to temporary Batwa village outside of Goma.	Mubanbilo community	Village currently accommodating almost twice as many families due to housing Batwa displaced by nearby volcanic eruption. No access to PIDP radio broadcasts due to no local receiver station, only possible to hear broadcasts if pre-recorded on cassettes & supplied with radio/cassette player.	Identification of Batwa's vulnerability to natural disasters as another aspect of marginalisation & general experience of insecurity. Very limited radio access & dependence on (often unhelpful) neighbours to access radio programmes. Need for radios to access current affairs & news first-hand.	Investigate possibility of incorporating recordings of PIDP broadcasts to be made & distribute with radio-cassette players/ recorders to vulnerable isolated Batwa communities. Need for expansion of PIDP activities to North Kivu.
24.03	Transit from Goma to Kigali – arrival late afternoon				
25.03	REST DAY				
26.03	Feedback to CAURWA on study findings in the DRC.	CAURWA	Demonstration of new torch/powerpack design is well received, as is sample solar module produced by PIDP technicians.	Welcome reception of DRC findings & suggestion of remainder of study focusing on making links with potential local collaborators for DIY technology transfer.	Schedule meeting for gathering of information on activities being undertaken by the various Batwa associations that CAURWA assists.
	Follow-up meeting with KIST staff	Ravikumar Kandasamy Albert Butare	Meeting with vice-rector (founder) of KIST.	High-level of interest from KIST in assisting the transfer of DIY technologies. Arranges meeting with minister to talk about possibilities.	Feedback after meeting with minister & generally agreement to explore possibilities for future collaboration.
	Meeting with minister for primary & secondary education	Dr Mudidi	Brief meeting with minister to demonstrate DIY technologies & promote possibilities for using them to assist education in rural areas.	Specific interest of minister in possibilities for local assembly of *DIY Solar* science kits rather than 'solar radio' power supplies.	Agree to explore possible local assembly of science kits. No serious interest in exploring use of technologies for increasing rural access to information.
	Development of photos taken on DRC visits				

	Development of photos taken on DRC visits				
27.03	Visit to Pottery Project outlet & demonstration to staff	Pottery Project	Demonstration of technologies inspires staff to explore possibilities for solar powering the phones used to communicate with isolated Batwa community associations.	Request to test *DIY Solar* mobile phone charging solar module. Agreement in principle in possibilities for future collaboration through sales of technologies to members earning income through the Pottery Project.	Donation of DIY technologies for trials once study completed. Keep in contact & explore possibilities while formulating proposed *DIY Solar* transfer project.
28.03	Follow-up meeting with possible local *DIY Solar* counterpart Steve B.	Steve Barker	Presentation of revised technology designs & PIDP sample technologies. Proposal for Steve to oversee production of trial technologies.	Agreement for Steve to produce Rwandan trial modules in absence of capable technicians being attached to CAURWA.	
	Purchase of materials	Kigali hardware & electrical stores	Purchase of final necessary materials with which to produce Rwandan trial technologies.		Supply Steve with materials & briefing on how to assemble required technologies.
29.03	Preparation of Rwandan torch/ powerpacks.	Leo Blyth	Incorporation of findings & feedback from the DRC demonstrations into final designs for trial technologies.	Production of torch/powerpacks for Rwandan trials.	Use samples for trials & continue to revise designs according to user feedback.
	Meeting with British Embassy Small grants fund contact.	Robert Kamuratsi Small Grants Fund, British Embassy, Kigali	Demonstration of technologies & briefing on findings so far. Understanding of Batwa situations & appreciative of potential for DIY technologies to improve conditions.	Very eager to see feasibility study scaled up into actual technology transfer project.	Send copy of report & work closely to develop full *DIY Solar* technology transfer project.
30.03	Further preparation of Rwandan torch/powerpacks .	Leo Blyth	Continuation of final preparation of DIY technologies for Rwandan trials.	Completion of remaining torch powerpacks.	Use samples for trials & continue to revise designs according to user feedback.
31.03	REST DAY				
1.04	Final meeting with local businessmen	Gabo Wilson & associates	Further talks with selected local businessmen. Explanation concerning the possibility of them importing *DIY Solar* materials & marketing the end products.	Development of idea that commercial sourcing of the required DIY materials could be carried out by a business, combined with local assembly of final technologies by Batwa micro-enterprises.	Incorporate commercial possibilities into technology transfer strategy.
	Assembly briefing with Steve.	Steve Barker	Visit to home workshop facilities, explanation & demonstration of assembly techniques.	Commitment by Steve to produce the necessary DIY modules & basic battery packs.	Use samples for trials, revise designs according to user feedback & assess future technical assistance role.

	Collection of materials from CAURWA.	CAURWA	Gathering of background information on Batwa associations that CAURWA works with.		Incorporate information into report.
2.04	Meeting with KIST staff.	Ravikumar Kandasamy Osmund Kaunde kaunde@KIST.ac.rw	Meeting with manager of Kist's new venture, the Centre for Innovation & Technology Transfer (CITT).	Manager interested in incorporating the proposed DIY technology transfer project into CITT activities.	Provide manager with report & collaborate to prepare future technology transfer project.
3.04	Final Pottery Project meeting.	Elaine Gardener	Discussion of possibilities for collaboration.	Suggestion of preparing a combined proposal for equipping the new workshop for 'Asuman' pottery association.	Request updates on Pottery project progress & incorporate Pottery Project associations into DIY technology transfer project.
4.04	Compilation of findings for presentation to CAURWA.	Leo Blyth	Production of simple overview of findings & recommendations for possible local assembly strategies		Present to CAURWA management.
5.04	CAURWA planning meeting.	CAURWA	Presentation of findings to project coordinator & Programme manager & discussion of CAURWAs role in the distribution of trial DIY technologies to selected communities.	Satisfaction of CAURWA management with feasibility study, agreement on the communities to participate in DIY trials.	Provide copy of report to CAURWA & work closely to prepare a technology transfer project based on the reports findings.

Annex 2: Feedback from brainstorming meeting with Bukavu Batwa NGOs

An open meeting was held (as indicated in the activity schedule) with representatives of all the 'Batwa NGOs' that operate out of Bukavu, DRC. These NGOs share common goals of disseminating developmental information, advocating for the fulfilment of the human and legal rights and ultimately assisting the development of minority groups and/or indigenous people in the region.

This meeting aimed to identify how *DIY Solar* technologies could assist the NGOs in their community work and whether the production and/or use of these technologies could possibly be undertaken within their programmes and activities. Following a presentation on the potential developmental uses of micro-solar systems the participants provided the following feedback:

There was a clear consensus that:

DIY technologies could bring great benefits through:

- Enhanced access to information amongst Batwa communities by solar powering radios that are currently prohibitively expensive using disposable dry cell batteries.
- Providing direct long distance communication services to Batwa communities by solar powering mobile phones for which there are no other realistic power supply options.
- Increasing range of possible night-time activities, safety in the home and generally improve living conditions amongst Batwa communities by replacing dangerous, unhealthy and relatively dim forms of flame based lighting with safe, clean and bright solar powered electric lighting.
- Use of portable solar powerpacks by Batwa NGO extension workers/animators to ensure power supply for their mobile phone communications while in the field.

Locally made *DIY Solar* technologies would be suitable for meeting Batwa needs:

- The quality of locally assembled solar systems (brought for demonstration from Uganda) was agreed as acceptable. The one design problem – no guaranteed all-weather protection – could be easily overcome, participants suggested, because there are always enough people around in the target communities to ensure that solar modules would always be taken inside before rain could damage them, providing that users were sensitised about the need for protection and careful use of modules.
- Lower-cost locally assembled solar panels (made specifically for trials in the feasibility study) were also demonstrated and assessed. It was unanimously agreed that they were very likely to be easily damaged and did not have enough protection, although their appearance and performance were acceptable and their lower cost was a big benefit. This was followed by the recommendation that the 'Batwa' solar modules be fashioned like those made in Uganda – with sturdy wooden frames.
- Suggestion that local assembly of appropriate low-cost *DIY Solar* technologies would be viable as long as a complete package of training, payment for premises, employment of personnel, good management and reliable supply of materials were put in place.

Annex 3: Distribution & end-use of trial DIY Solar Powerpacks (DSPs)

Name/reference for recipients	Location	Country	NGO responsible	Size of system	End use of system
PIDP	Bukavu	DRC	PIDP	Small & Medium	Trials of DSP's useful applications within the organisation & community demonstrations throughout Kivu province.
Muyange Community	Kabare	DRC	PIDP	Small	Community trial of DSP's usefulness & limitations.
Bushulishulie community	Kalehe	DRC	PIDP	Medium	Community trial of DSP's usefulness & limitations.
Kisize community	South Idjwi	DRC	PIDP	Small	Community trial of DSP's usefulness & limitations.
Buruhka community	North Idjwi	DRC	PIDP	Medium	Community trial of DSP's usefulness & limitations.
Buze community	North Idjwi	DRC	PIDP	Medium	Community trial of DSP's usefulness & limitations.
Kachuba community	North Idjwi	DRC	PIDP	Small	Community trial of DSP's usefulness & limitations.
Shenge community	North Idjwi	DRC	PIDP	Small	Community trial of DSP's usefulness & limitations.
Bugarula community	North Idjwi	DRC	PIDP	Medium	Community trial of DSP's usefulness & limitations.
CAURWA	Kigali	Rwanda	CAURWA	Small & Medium	Trials of DSP's useful applications within the organisation & community demonstrations throughout Rwanda.
Bugarama association	Gitarama	Rwanda	CAURWA	Medium	Community trial of DSP's usefulness & limitations.
Abegesendo association	Gitarama	Rwanda	CAURWA	Medium	Community trial of DSP's usefulness & limitations.
Dufashanye association	Gikongoro	Rwanda	CAURWA	Small	Community trial of DSP's usefulness & limitations.
Abishizehamwe association	Gikongoro	Rwanda	CAURWA	Small	Community trial of DSP's usefulness & limitations.
Ingobokasigo association	Gikongoro	Rwanda	CAURWA	Small	Community trial of DSP's usefulness & limitations.
Pottery project	Kigali	Rwanda	CAURWA	Small & Large	Trials of DSP's useful applications within the organisation & community demonstrations to Pottery associations throughout Rwanda.
Enterprise creation	Kigali	Rwanda	CAURWA	Medium	Demonstrations & survey of potential market for DSPs amongst the wider non-Batwa population.
Assembly & training	Kigali	Rwanda	CAURWA	Small & Medium	Ongoing research & trials into the design of DSPs.

Annex 4: Design criteria for DIY Solar technologies (DSPs)

All the proposed systems are designed to provide solar electricity supplies that are:

Affordable
Low absolute cost of DSPs minimises the first cost purchase barrier that typically restricts individual or donor purchases, while also reducing the systems payback time to approximately six months of use (compared to the cost of similar utility using locally available disposable batteries).
Low relative cost when considering that once purchased, DSPs provide 'free power' at zero marginal cost for the duration of their operation.

Reliable & Durable
Rugged construction of DSPs, quality controlled assembly and use of good quality components ensures robust and reliable units.
Innovative and thoroughly researched design provides dependable performance.

User friendly
Each DSP provides a self-regulated supply of maintenance-free electricity and frees users from dependence on outside forces (other than abundant and universally available solar energy).
Innovative design of all units enables completely portable use.
DSP's modular design, using a separate solar panel and battery pack enables stored electricity to be available for use at the user's convenience in the battery pack, while the solar panel can be either secured away or used for another application.
'Plug and play' design ensures straightforward 'foolproof' operation, while multiple adapters fit all likely power sockets.

Annex 5: Specifications of proposed DIY Solar Powerpacks (DSPs)

The individual capacities and specifications of the DSPs are detailed below:

Basic DSP

Specifications

- 1wp (4.5v/150mA) a-Si Solar module, 3m cable-flex & 2.5mm plug output
- 3.6v/320mAh NiMH (Nickel Metal Hydride) battery pack, 1m cable-flex & 2.5mm plug output LED (Light Emitting Diode) 'light-plug'

Performance: a full days sun able to

- Solar module: Power a 3–6v radio all day and fully charge the battery pack with enough stored power to enable one or a mixture of the following services:
- Battery pack: Power a 3–6v radio for six–ten hours, OR
- Battery pack: Power a custom-made low consumption LED light-plug for ten hours.

Advanced DSP

Specifications

- 1.5wp (6v/300mA) a-Si Solar module, 3m cable-flex & 2.5mm plug output
- 4.8v/850mAh NiMH battery pack, inside a conventional torch housing with standard torch bulb, 1m cable-flex & 2.5mm plug output

Performance: in a full days sun able to

- Solar module = Power a 3–6v radio all day or a mobile phone on stand-by and fully charge the battery pack with enough stored power to enable one or a mixture of the following services:
- Battery pack: power a 3–12v radio for 16–30 hours, OR
- Battery pack: power a 6–12v cassette player for three–four hours, OR
- Battery pack: power integral torch for three–four hours, OR
- Battery pack: recharge a mobile phone battery of typical capacity, or, if mobile battery is full, to directly power either a further two hours' talk time, eight hours' stand-by or a mixture of the two.

Universal DSP

Specifications

- 3wp (6v/600mA or 12v/300mA) a-Si Solar module, 3m cable-flex & 2.5mm plug output
- 6v/8Ah or 12v/4Ah sealed lead acid battery pack, incorporating battery management circuitry within a durable metal housing with shoulder carry-strap and twin outputs of 1m cable-flex & 2.5mm plugs

Performance: in a full day's sun able to

- Battery pack: power a 3–12v radio for 48–90 hours, OR
- Battery pack: power a 6–12v cassette player for 12–16 hours, OR
- Battery pack: power integral torch for 12–16 hours, OR
- Battery pack: recharge a mobile phone battery of typical capacity, or, if mobile battery is full, to directly power either a further six hours' talk time, 24 hours' stand-by or a mixture of the two.
- Battery pack: simultaneously power two appliances e.g. power a radio while recharging a mobile phone.
- Battery pack: power a conventional 12v energy-saver fluorescent light for four hours (based on using a 6-watt light, a higher wattage would simply run for less time.