JUMEMAJI

100 Watts every family

Food, water, light, communications

Enhance food production

Improve health and hygiene

Provide a basic electricity supply

Save time and labour

Reduce environmental impact of farming

for

Millions of households and small community groups

in Africa

and other Tropical Regions

using

proven award-winning pumping technology

harnessing solar energy

on a self-financing, economically sustainable basis

Concept Paper

Bobby Lambert May 2007

EXECUTIVE SUMMARY

Solar power offers great potential for improving food security for millions of people in Africa and other water-stressed parts of the world. Up until recently it has not been economically viable, although it is now beginning to spread for specialised use. By coupling a small (100 Watts) solar photovoltaic panel with simple proven pumping technology, modest quantities of water can be provided for irrigation and domestic use at household (or small community) level. The income from this irrigation can pay for the solar panel, which is then available for other uses, such as lighting. The possibility exists to bring sustainable electric power to millions of rural families in Africa and other tropical regions.

This would deliver the following benefits:

- Improved family nutrition through economically viable household food production
- Improved health associated with sufficient clean water
- Improvements in household economics through sale of irrigation produce
- Improved opportunities for education & other economic activities through reduction in labour required for food production & water collection
- Improved electricity availability for domestic and small community use
- Enhanced attractiveness of solar power as a viable energy source, through adding another level of economically viable functionality
- Improved environment through reduced soil erosion associated with well watered soil

The package is designed to fit into the social, economic, agricultural, hydrological and environmental circumstances in large parts of Africa and other tropical areas, where water scarcity is a major constraint on food production, where modest amount of groundwater is available within 30 metres of the surface and where there is poor access to electric or other sources of power. The increase in food production possible with the package allows it to be financially viable with a payback period of several years.

The technical package consists of a small, 50-100 Watt, solar panel powering a small electric motor which turns a simple, locally made rope-washer pump. PumpAid (www.pumpaid.org) have recently won a major World Bank award for their work with this pump, with thousands now operating successfully in rural Africa. To make this technology available, a development and dissemination project is being put together, which will involve:

- technical and economic verification of the integrated solar pumping package including piloting of the package in real conditions;
- development of a sustainable social enterprise business model incorporating market forces and the private sector. This will involve local artisan suppliers possibly linked to the growing number of micro-finance schemes
- appropriate partnerships (NGO, commercial, government, academic) to provide the institutional support and monitoring
- pump-priming funding
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The initiative is being developed in partnership with PumpAid (www.pumpaid.org) and London South Bank University, with advice from SolarAid (www.solar-aid.org.uk) .

BACKGROUND AND RATIONALE

Far too many people in poor countries suffer from poor nutrition. Children go to be hungry and they and their parents are susceptible to diseases associated with poor nutrition. In the fight against HIV/Aids it is recognised that a key ingredient is good nutrition. For a huge number of people in the rural tropics their nutritional status depends on their ability to grow their own food. In addition to meeting their nutritional requirements, improving food production offers the potential for significant economic returns. Furthermore, improved food production has additional benefits for the wider society in which they live, through improving access to food itself and through associated economic activities.

Food production in large parts of the semi-arid tropics is constrained principally by the availability of sufficient water to meet crop requirements. This is because rainfall is seasonal, erratic, often insufficient to meet crop needs and because other water sources, such as rivers or springs are scarce or difficult to access.

Maize is a staple food in much of the semi-arid tropics. A family's food requirement is approximately one tonne of maize per year. In the semi-arid tropics low yields of 2 tonne/hectare (or less) are very common, requiring cultivation of a plot of 0.5 hectares to give enough food for the family. Where sufficient and reliable water is available to meet crop requirements, high yields of up to 10 tonnes/hectare are possible – and achieved regularly by small-scale farmers. At these high yields, enough food can be grown on a much smaller plot of 0.1 ha (20x50 metres). The high yields are possible because with sufficient reliable water, it is worthwhile investing in the fertilisers, weed and pest control that will give a high yield. The difference in value of a high crop yield versus a low yield on this small plot can be up to $160 and proportionately more for larger plot sizes. With good water supply, other crops can be grown throughout most of the year, increasing the amount and diversity of food and the economic return from this plot.

A major problem in maize (and other cereal) production is the phenomenon of "mid-season drought". Maize is generally planted soon after the first rains. As it germinates and develops its water requirements steadily rise. At a critical stage in its development (tasseling) it is very vulnerable to water stress. If there is a gap in the rains at this point – and no way of supplementing from other sources – yields fall dramatically. Having the capacity to supplement the rainfall with relatively small quantities of water can turn a very poor yield into a high yield.

So if the rains are erratic, where is this water to come from? The answer in many areas is in the ground. In much of Africa groundwater is accessible at relatively shallow depths (up to 30 metres – the maximum realistic depth of a hand-dug or hand-drilled well). At greater depths of up to 100 metres, mechanical drilling of smaller diameter boreholes is required – with a greater cost in pumping technology and energy. However, where water is only available at greater depths, it is also considerably more valuable – so there is not a simple "maximum viable depth". Groundwater is recharged from rainfall; and for shallow aquifers, this means local rainfall (deeper aquifers may be recharged by rain falling at a considerable distance away). Thus shallow groundwater is generally more available later in the rainy season (at the time when the mid-season drought typically occurs), and in the early dry season, when the rain has had time to percolate down into the ground.

Groundwater aquifer yields are low in much of the semi-arid regions. Wells yielding less than about 1 litre/second (enough water to irrigate about 1 hectare) are not considered commercially viable. However, with this system, well yields of as little as 0.05 litres per second are viable, greatly increasing the area where this technology is viable.

Accessing groundwater requires an investment in technology and a secure source of energy to raise the water. A considerable amount of work has been done in developing simple well digging and drilling technologies. Much work has also been done on developing simple hand-operated water pumps for domestic water supply. An excellent example is the work of Pumpaid, which has recently won a major World Bank Development Marketplace award (see www.pumpaid.org).

Raising water from a well with a hand-pump is hard work – and requires a lot of energy. To satisfy a family's domestic water needs, it may be necessary to pump (and carry) 100 litres every day. However this is very little compared with the amount of water required for even quite modest amounts of irrigation. At the height of the season, the maize growing on a small plot of 0.1 hectares (1,000 square metres) will need about 5 litres for every square metre, every day – or 5,000 litres per day (50 times the family's domestic requirements). To lift this amount of water from even a fairly modest 10 metre depth would take one person about 6 hours of pumping. It requires a power delivery of about 50 Watts - which is what a fairly healthy human can sustain over time, or what can be delivered by a modestly sized solar panel.

Labour is freed up in a number of ways through a reduction in the time and effort required for soil cultivation and through a reduction in the amount of time needed to raise and carry water. This labour is available for other productive activities.

Soil erosion is a major concern in the semi-arid tropics. Soil is particularly vulnerable to erosion at the onset of the rainy season, when there is poor vegetative cover to protect the soil. Where water supply is good, crops become established quickly, providing good vegetative cover. Other forms of soil and crop husbandry conservation (contouring, mulching etc) are also more viable. Because high yields are possible, there is less need to cultivate large areas of land. Where water supply is poor, farmers must compensate by increasing the amount of land they must cultivate. Thus a larger area of soil is exposed to erosion. This cultivation takes more time and there is less time available to put into soil and crop husbandry.

TECHNICAL PACKAGE

The technical package includes a low-power solar panel (say 50 to 100W) powering a simple locally made pump via a small electric motor. It is illustrated schematically in the accompanying diagram on the next page.

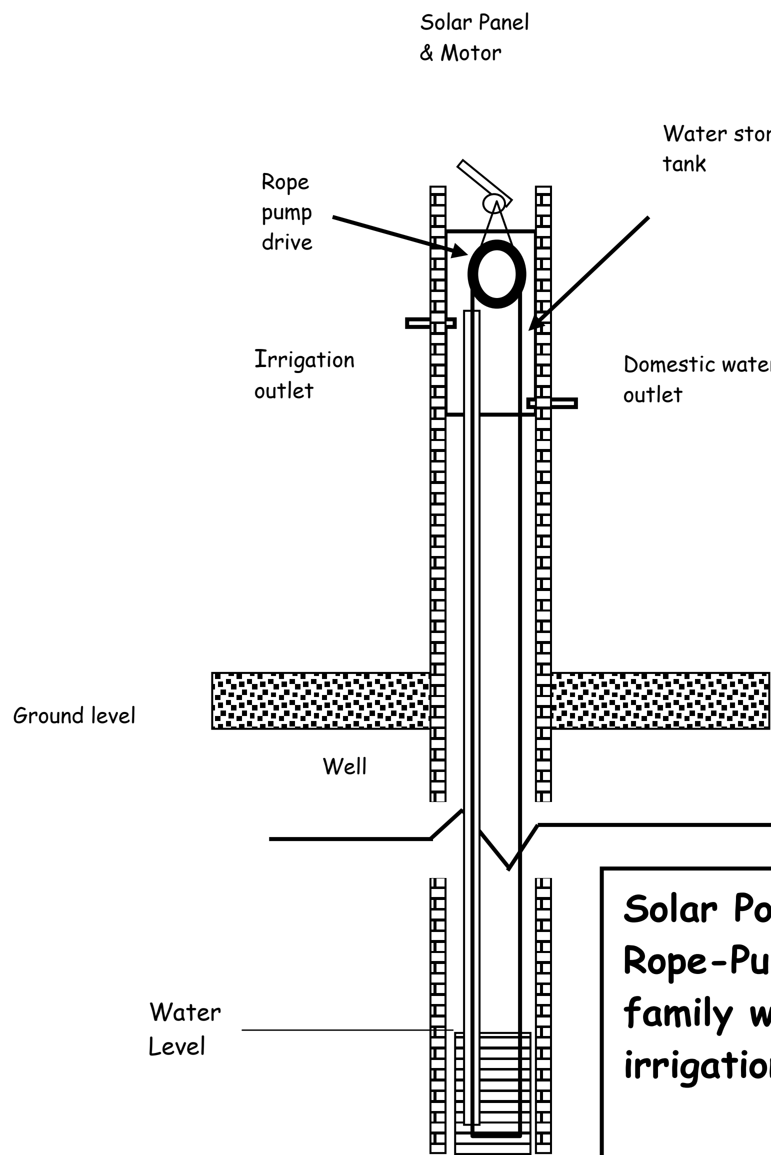
A simple pump (rope-washer), is now spreading widely in Africa, It can be built by the users or local artisans. See the work of PumpAid (www.pumpaid.org), who have taken this forward, with some half a million people already benefiting from this in Zimbabwe. The pump has also be en worked on extensively by others. Features of the pump include simplicity, very low starting torque, no valves, low speed, ease of maintenance and repair on site, and low-cost of construction.

Picture from PumpAid

Ideally a hand-dug (large diameter, 80-100 cm) well would be used, although there is scope to use smaller diameter (15cm) boreholes. The well superstructure is extended above ground to form a tower, which contains a water storage tank and acts as a platform for the solar panel and pump.

A simple irrigation system (20 metres of 50mm plastic pipe) is needed and it is important that this is operated correctly.

Estimates from Pumpaid give the cost of installing a simple well and pump package at under US$1,000 per unit. A solar pumping and simple irrigation package might add an estimated further US$1,000 to this price. This is considerably less than the US$10,000 cost of conventional well and hand-pump installations.



Solar Powered Rope-Pump for family water & irrigation

Schematic
Bobby Lambert
September 2006

WHO WE ARE

The following people have agreed to form an interest group to move this initiative forward.

Alex Murdock Head of Centre for Government and Charity Management LSBU – Knows about Social Enterprise and well networked in voluntary sector

Brian Burgess Engineer with Public and Private sector background. A social entrepreneur (re-engineered Brentford United FC to be a community-led project) involved with the Community Action Network

Ian Neal Engineer with Engineers against Poverty, extensive network of contacts in the sector.

Ian Thorpe CEO of PumpAid, who have installed thousands of rope-washer (Elephant) pumps. Ian spends much of his time in Africa and is in London for this period.

Lachlan Bateman Engineer with SolarCentury, a thriving commercial solar photovoltaic company in the UK

Nick Sireau CEO of SolarAid, a new NGO set up to support solar power in developing countries.

Roger Keenan Engineer and businessman, built a successful company around an engineering innovation. One of his current hats is as a social entrepreneur.

Bobby Lambert a Chartered Engineer with 25 years professional experience. He has 12 years practical experience in rural development in Africa, including 8 years of academic and field based research, mainly in Zimbabwe in the late 1980s (sample publications listed below). He served as Chief Executive of RedR-Engineers for Disaster Relief until August 2006.

This proposal is based on his 10 years experience in rural development in Africa, including 8 years of academic and field based research, mainly in Zimbabwe in the late 1980s (sample publications listed below). This research indicated that this technology was economically viable in 1992 (compared with manual labour at US$1/day), especially if linked to a micro-credit scheme. Since then the viability of the pumping technology has been evidenced by Pumpaid's success in developing and promoting this as a community water technology in large parts of Southern Africa (they recently received a major World Bank award for their work). The viability of solar photo-voltaic technology has dramatically increased in Africa, with Kenya having the highest per capita installation of PV units in the world.