talentwith**energy**



OFF-GRID LIGHTING Product Life-cycle Management Options

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1. Off-grid Lighting Technologies

- 2. Product Quality and Performance
- 3. End-of-life Management Issues
- 4. Product Life-cycle Management Options
- 5. Supply-chain and Product Life-cycle Management

6. Recommendations

talentwithenergy is an Australian-based strategic project management services consultancy specialized in sustainable and emerging energy technologies.

LMC is a New Zealand-based management consultancy specializing in lighting infrastructure planning, procurement and management

A joint program of the International Finance Corporation and the World Bank.

Builds on the IFC's Lighting Africa Initiative

- ~780,000 off-grid lighting products deployed
- 3.8 million customers

STRATEGIC PRODUCT LIFE-CYCLE MANAGEMENT PLAN

Talent with Energy (TwE) and Lighting Management Consultants (LMC) engaged by the IFC to develop a *Strategic Product Life-cycle Management Plan* for the Lighting Global Initiative

Key focus: minimization of end-of-life waste management issues through

> improved product design,

> the implementation of national and sub-national product stewardship schemes, and

 > in-country capacity building in the area of waste electric and electronic equipment (WEEE) management infrastructures.

Key activities and timeline:

- > Background research (Sep-Nov 2012)
- > In-country stakeholder engagement (Nov 2012-Mar 2013)
- > Draft Strategic Plan (Mar 2013)
- > International workshops (Apr-May 2013)
- > Final Strategic Plan (June 2013)

OFF-GRID LIGHTING TECHNOLOGIES

TECHNOLOGY CLASSIFICATION

by Product Typology

- Flashlight/Torches
- Ambient Lamps
- Ambient Lamps/Work Lights
- Multi-Functional Devices
- Micro SHS

by Performance

- Lumen Output
- Luminous efficacy (lumen/W)
- Lifespan (shortest lived component)
- Cost
- Autonomy (hours/charge)
- Charging time (hours/charge)



Broad spectrum of product performance emerging



Significant outliers exist in independently tested data which have been omitted pending further analysis

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COMPONENT-LEVEL TECHNOLOGY OPTIONS

Lighting subsystem

- LED
- CFL

Storage subsystem

- SLA
- NiCd
- NiMH
- Li-lon

Power subsystem

- Mono-Poly Crystalline PV
- Thin-film (Amorphous) PV
- Other (dynamo)



Source: Lighting Africa 2010

LED

- In 2010, 64% of new product entrants were LED lanterns
- LED module lifetime up to 100,000 hours, 10 years
- Continuously improving luminous efficacy and decreasing costs

CFL

- Traditionally the predominant SPL lamp type but now decreasing
- Lifetime 7,500-10,000 hours
- Higher ambient temperatures can reduce light output

STORAGE SUBSYSTEM

SLA

- The traditional standard option
- In 2010, 35% market share and decreasing
- 200-300 Recharge Cycles
- Low durability rating
- High Toxic

NiCd

- In 2010, <5% market share and decreasing
- 1500 Recharge Cycles
- Highest durability rating
- Acutely toxic

NiMH

- In 2010, 55% market share and decreasing
- 300-500 Recharge Cycles
- High durability rating
- Benign toxicity

Li-lon

- In 2010, <5% market share and rapidly growing
- 300-1000+ Recharge Cycles
- High durability rating
- Benign toxicity



Source: Lighting Africa 2010

POWER SUBSYSTEM

Crystalline PV

- In 2010, 85% market share and decreasing
- Efficiency ranging from 12-22%

Thin-film PV

- In 2010, 15% market share and increasing
- Efficiency rating 6-9%
- Rural preference for larger, more 'substantial' products is a key driver for growth

PRODUCT QUALITY AND PERFORMANCE

Ingress Protection Rating

- International Electrotechnical Commission (IEC) Standard
- Consists of letters IP followed by two numbers representing increasing levels of protection against solid objects and water eg IP54

First	Protection Against	Second	Protection Against
Number	(dust, foreigh object)	Number	(water)
0	None	0	None
I	Solid objects larger than 50 mm	I.	Vertically falling water drops
2	Solid objects larger than 12.5 mm	2	Vertically falling water drops even when enclosure is tilted at 15°
3	Solid objects larger than 2.5 mm	3	Spraying water
4	Solid objects larger than 1.0 mm	4	Splashing water
5	Dust	5	Water jets
6	Dusttight	6	Powerful water jets
	-	7	Temporary immersion in water
		8	Continuous immersion in water

Lighting Africa Minimum Performance and Standards

- Approved once product passed Lighting Africa Methodology
- Requires re-testing every 2 years
- In 2012, being adapted to global standards
- Covers: information, illumination, energy system performance
- Lumen maintenance, charge, storage and quality and durability

• e.g.

	Physical	Fixed	ID 5r	
	Ingress	Outdoor	IF 5X	
	Protection	Others	IP 2x	
		Fixed Indoor	no requirement	
		Portable	Occasional rain:	
	Wistow	Separate	IP x1 OR technical equivalent OR with warning label	
	Water	Portable	Frequent rain:	
Out the set	Protection	Integrated	IP x3 OR technical equivalent OR IP x1/equivalent + warning label	
Quality and Dunahility		Fixed	Permanent outdoor exposure:	
Durability		Outdoor	IP x3 AND circuit protection	
	Drop Test	Fixed Indoor	None result in dangerous failures ⁱⁱⁱ	
		Others	5 out of 6 samples are functional after drop test (1m onto	
			concrete); none result in dangerous failures	
	Soldering and Electronics		Pass Soldering and Electronics Inspection	
	Quality		(without endemic bad joints, pinched wires, etc.)	
	Switch, Gooseneck, and		5 out of 6 samples are functional after 1000 cycles; none	
	Connector Durability		result in dangerous failures ^v	

END-OF LIFE MANAGEMENT ISSUES

RECYCLING SPL SYSTEMS

Lighting subsystem

- Recycling Process
 - Separated, Shredded, Crushed, sorted into individual components (glass, metals, plastics)
- Hazardous Materials
 - Mercury
 - Primarily used in CFL lamps
 - European current RoHS limit of 5mg/lamp
 - Content varies according to shape, diameter, length, brand, age etc.

Power subsystem

- Solar Panels 20-30 year lifetime
- Recycling Process
 - Silicone Crystalline panels pyrolysis
 - Ethylene Acetate vaporised, silicone crystalline recovered

RECYCLING SPL SYSTEMS

Batteries

- Recycling Process
 - 3 basic methods of battery recycling
 - 1. Separation of components
 - 2. Hydrometallurgy
 - 3. Pyrometallurgy
- Hazardous Materials
 - Lead
 - SLA batteries can contain up to 65% lead
 - Exposure to lead, leads to neurological damage
 - Cadmium
 - Mostly prevalent in NiCd batteries
 - Exposure associated with human, lung and bone damage

LIFE CYCLE ASSESSMENT

- How do we quantify the holistic impact of materials/products/systems?
- A key standard is "ISO 14040 Environmental Management Life Cycle Assessment Principles and Framework"
- This gives us a framework to measure the impacts of the life-cycle phases to provide a quantitative picture of the total environmental impact of a product or system over the whole-of-life.
- The LCA "Functional Unit" is an output based systemic measure that can be used as a planning tool to develop preventative measures to reduce the size of the task of physical product handling, take-back and waste processing.

A possible SPL FU might be..... "Impacts per unit of light output over product life"

• e.g.

- LC Economic Impact Dollars/lumen-hour
- LC Lead Impact kg Lead/lumen-hour
- LC Mercury Impact- mg Mercury/lumen-hour

ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

- One of the ISO 14000 series is "ISO 14025 Environmental Labels and Declarations Type III Environmental Declarations - Principles and Procedures"
- This is a generic LCA based methodology for product manufacturers to quantitatively express and seek verification for the environmental performance of their products.
 But implementation of this requires specific and detailed Product Category Rules (PCRs)

• The first PCRs for the lighting industry have recently been developed by the German organisation IBU (Institut Bauen und Umwelt), the German Institute for Construction and Environment.

"Requirements on the EPD for Luminaires, Lamps and Components for Luminaires".

• This now allows lighting stakeholders to quantify, verify and declare holistic performance. This can enable/assist the of minimisation at source the of waste impacts for products supplied in the future.

PRODUCT LIFE-CYCLE MANAGEMENT OPTIONS

THE BASEL CONVENTION

- Basel Convention on the "Control of Transboundary Movements (TBM) of Hazardous Wastes and Their Disposal" is the most comprehensive global environmental agreement on hazardous wastes and other wastes.
- Principles to be considered in the Development of Waste and Hazardous Waste Strategies.
 - Source Reduction Principle
 - Integrated Life-Cycle Principle
 - Precautionary Principle
 - Integrated Pollution Control Principle
 - Standardisation Principle
 - Self-Sufficency Principle
 - Proximity Principle
 - Least Transboundary Movement Principle
 - Polluter Pays Principle
 - Principle of Sovereignty
 - Principle of Public Participation

- E-waste Africa Project.
 - Aim: "Enhancing the environmental governance of e-wastes and creating favourable social and economic conditions for partnerships in recycling."
 - Report: "Where are WEEE in Africa?" focuses on socio-economic impacts and the impact of imports of European end-of-life e-waste to these countries.
 - Useful base for the evolution of off-grid lighting waste management activities.
- Mobile Phone Partnership Initiative

Ai	ms	Le	essons
• • •	Better product stewardship; Influence consumer behaviour towards more environmentally friendly actions; Promote the best refurbishing/recycling/ disposal options; Mobilise political and institutional support; Public/private partnerships for the management waste		Strong and continued leadership is crucial. All stakeholders need to be actively involved. Agreed self-funding mechanism Sound coordination of activities Success rests on finding committed officials to lead projects. Mechanisms should be established for reaching consensus or resolving conflict/legal issues
		•	The work programme needs to be flexible and allow for adjustments along the way

 Issues that affect the waste impacts of SPLs are – design choices, materials choices, production and packaging choices.

A whole-of-life Product Strategy encompasses the following areas -

- Design for Longevity
- Design for Miniaturisation
- Design for Upgradability
- Design for Disassembly
- Sustainable Materials
- Sustainable Production
- Sustainable Packaging

- In order to collect as much e-waste as possible 3 issues need to be considered -
 - 1. The existence of adequate legislation
 - 2. Creation of public awareness
 - 3. Provision of countrywide collection systems
- Product Stewardship and Extended Producer Responsibility
 - Producer is responsible for managing the potential environmental effects of their problems from the point of sales through a product entire life-cycle.
 - Implementation through industry based "Joint Schemes"
 - Producer charging system is a contentious area. Avoiders ,free-riders, backsliders

Business Costs of Extended Producer Responsibility

Cost categories	Key cost categories
Transaction costs	Identifying appropriate solutions and contractual partners; negotiating and managing contracts, reporting
Collection	Containers at collection points, other equipment, maintenance, labour, transport, depending on waste volumes and distances between
	collection points. Storage in the case of retailer take-back; staff time for planning and administration of operations
Recycling	Labour, equipment and space for (manual or automated) sorting, disassembly and processing; depending on waste properties and volumes.
	Staff time for planning and administration of operations.
Miscellaneous	Provisions for environmental, health and safety protection. Waste management licences; auditing, information between different stakeholders.

PRODUCT STEWARDSHIP – REGULATED MARKETS

EU WEEE Directive 2002/96/EC Equipment Manufacture Responsibility for e-waste

- Sweden El-Kretsen
 - Annual membership fee + \$/unit
 - Collection through national recycling facilities
- UK Lumicom
 - Utilise previous years sales data multiplied by uniform disposal contribution
- Switzerland Swiss Lighting Recycling Foundation
 - Advanced Recycling Fee paid based on sales in the country
 - Collection at collection points & point of sale
- Denmark Elretur
 - Charges environmental fee based on either quantity or weight of products sold.
 - Collected at local recycling stations



SUPPLY CHAIN AND PRODUCT LIFE-CYCLE MANAGEMENT

SUPPLY CHAIN PROCESS – PRODUCT TAKEBACK LOGISTICS

Forward Supply Chain - Production Phase - Product Distribution Process



SUPPLY CHAIN PROCESS – LOCAL STAKEHOLDERS

Recognised manufacturers in Kenya and Ghana

Manufacturer	Head Office
Barefoot Power	Australia
Betta Lights	South Africa
d.light	USA
Greenlight Planet (SunKing)	USA
Global Telelinks	
Lemnis Solar (Pharox)	Netherlands
NIMH Technolinks	India
Nokero International Ltd.	USA
Nuru Lights	South Africa
Philips	Netherlands
Schneider Electric	France
Solux Service GmbH	Germany
SunNight Solar Enterprises	USA
SunTransfer	Germany
SunSumSolar	Taiwan
Sunlite	
Tough Stuff	Mauritius
Trony Solar Holdings Co. Ltd.	China
Uniglobe	

SUPPLY CHAIN PROCESS – LOCAL STAKEHOLDERS

Recognised Distributors in Kenya and Ghana

	Kenya		Ghana	
Manufacturer	Distributor	Location	Distributor	Location
Barefoot Power	Smart Solar (K) Ltd	Nairobi	Toyola Energy	Ofankor-Accra
			Impact Energies	Manfe- Akuapem
Betta Lights				
d.light	Sollatek Electronics	Nairobi	Adinkra solutions/Twum Be Lto	Accra
	Total Kenya Ltd	Nairobi	Sidithhomes GH	Adum Kumasi
Greenlight Planet (SunKing)	Sola Taa	Nairobi	Wilkins Engineering	Airport Accra
	Radbone Clark	Nairobi	Burro Ghana Limited	Koforidua, Eastern Region
	Renewable Energy Ventures (K)	Nairobi	Jigsaw Company Limited	Accra
Global Telekins	Mark Holdings	Nairobi		
Lemnis Solar (Pharox)	-		Sidithhomes GH	Adum Kumasi
			Dutch & Co Ltd	Accra-North
NIMH Technolinks	Deutrex 818 Ltd	Nairobi		
Nokero International Ltd.				
Nuru Lights	Nuru East Africa Ltd.	Nairobi		
Philips	Nabico Enterprises Ltd.	Nairobi	Deng Limited	Accra
Schneider Electric	Power Technics Ltd	Nairobi	-	
Solux Service GmbH	Hensolex Limited	Gilgil	Solar4Ghana Limited	Accra-North
SunNight Solar Enterprises				
SunTransfer	SunTransfer Kenya Limited	Nairobi		
SunSumSolar				
Sunlite	Kingfisher Consultants Ltd	Nairobi		
Tough Stuff	ToughStuff Kenya Ltd.	Nairobi		
Trony Solar Holdings Co. Ltd.	Trony Easy Africa Ltd.	Nairobi		
Uniglobe				

MANAGEMENT SUPPLY CHAIN AND PRODUCT LIFE-CYCLE

RECOMMENDATIONS (EARLY DIRECTIONS)

- Review product quality metrics/standards under a product life-cycle management perspective (highlight linkages between quality parameters and EoL management issues)
- Explore the feasibility of incorporating Life Cycle Assessment/Management (LCA/LCM) methods and metrics into the Lighting Global Quality Standards for off-grid lighting products.
- In-country assessment of potential synergies between product supplychain actors and EoL management infrastructure providers
- Explore the feasibility of collaboration with the ICT and mobile phone industries and the related stakeholder groups on waste collection, recycling and disposal tasks.
- Promote international stakeholder engagement initiatives (workshops)

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