the Learning Network on Sustainable energy systems

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Sustainable Energy for All – A multidisciplinary educational approach

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Contents

Introduction

- An estimated 1.2 billion people worldwide lack access to electricity
- 2.8 billion people rely on traditional biomass for cooking & heating
- DRE technologies are helping to improve these numbers by providing essential and productive energy services
- SPSS and SD4SEA can be used as a catalyst to accelerate the process.

Introduction

Solar Portable Lanterns

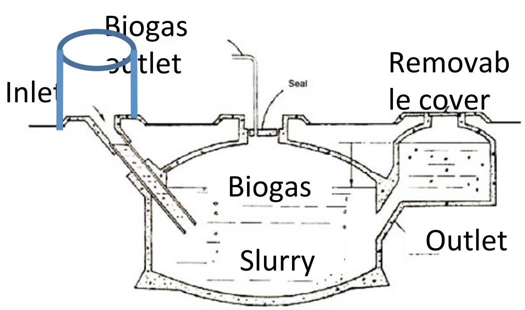
- $27 billion annually on kerosene lighting and gen-set mobile-phone charging globally.

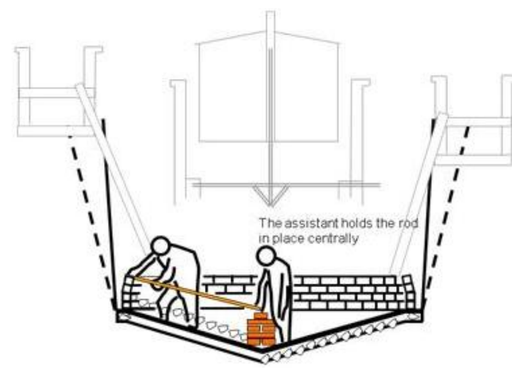
Country	Technology/system	Cumulative at end 2014	Additional information
Kenya	Solar PV (pico)	56,800	EnDev Programme
	Solar PV (pico)	695	SNV funded project
	Solar PV (pico)	1,574,078	GOGLA/World Bank
	Solar Kits		Oolux/REPIC project
	Solar Kits		Oolux/SYMPAHSIS
	Solar Lanterns	7,155	Implemented under SNV-project

Introduction

Biogas

- >14,000 domestic biogas plants have been implemented by SNV/HIVOS representing over 10,000 households.





- There is growing experience with community-scale.
  - PJ Dave 100 KW in Kajiado, Simbi Roses 55 KW in Kiambu, 150 KW Kilifi Sisal Biogas Plant, Gorge Farm 2.2 MW (grid-connect).

Introduction

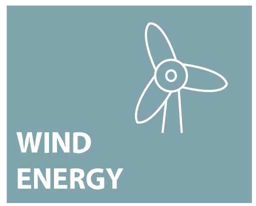
Solar PV

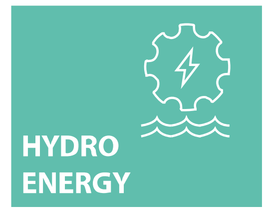
- Kenya has focused on increasing off-grid solar in isolated areas
- Currently there are 18 diesel mini grids operated by the National Utility with a total installed capacity of 19 MW (GSR 2015)

Isolated home systems	320,000	6-8 MW installed
Mini-grid (solar)	113 KWp	-A mini-grid (45 kW), -25 compact mini-grids (58 kW), -4 containerised mini-grids (10 kW) installed by ARE members

Implementation

The E.DRE from LENSES provides a quick means to estimate:





Implementation of each requires:

1. Continuous Training
2. Development of Standards
3. Enforcement of Regulations

Implementation

- Autonomous or Stand alone systems
- Grid connect systems

- From E.DRE
  - starting from your energy load/need

E= ENERGY NEED	kWh/year	2357.9
N= NOMINAL POWER	kWp	1.436

  - starting from surface different from the one calculated
  - starting from less or greater budget than that calculated

Implementation

A Photovoltaic (PV) module is both:

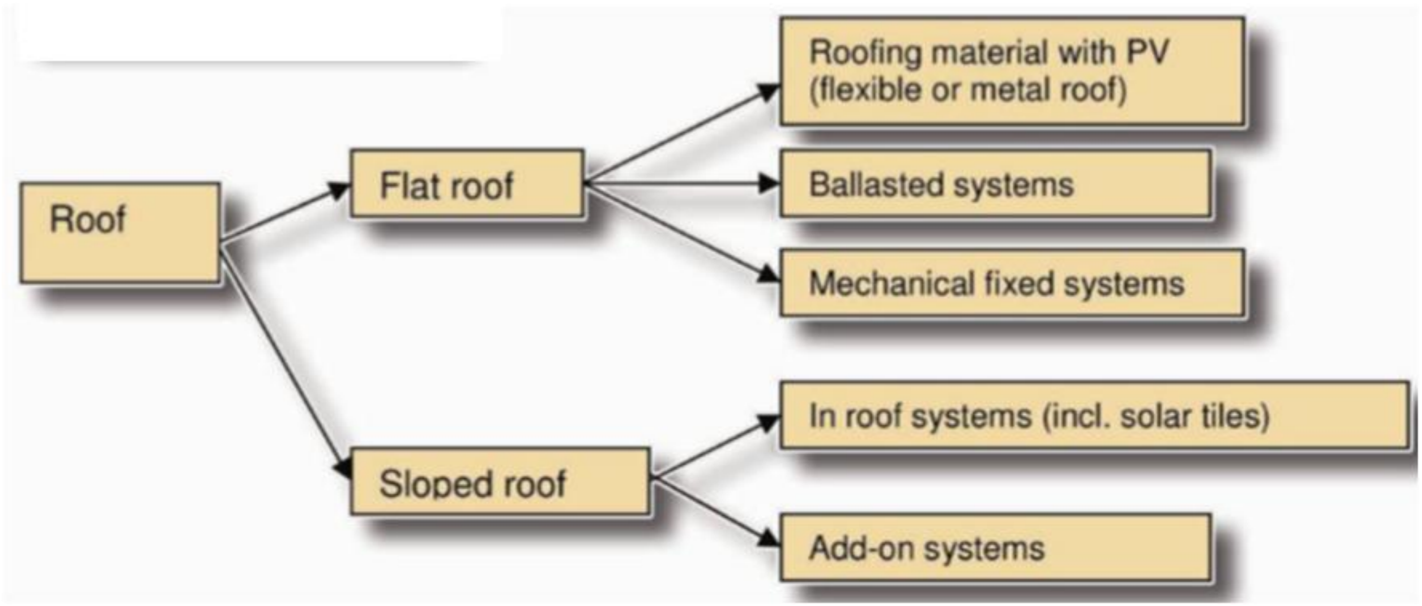
- An electric power source
- A covering material

PV can be:

1. Part of a traditional or new building product.
2. Integrated into the building skin.
3. A design element on a building.
4. Used in small scale applications such as powering a sun blind.

Implementation

1)



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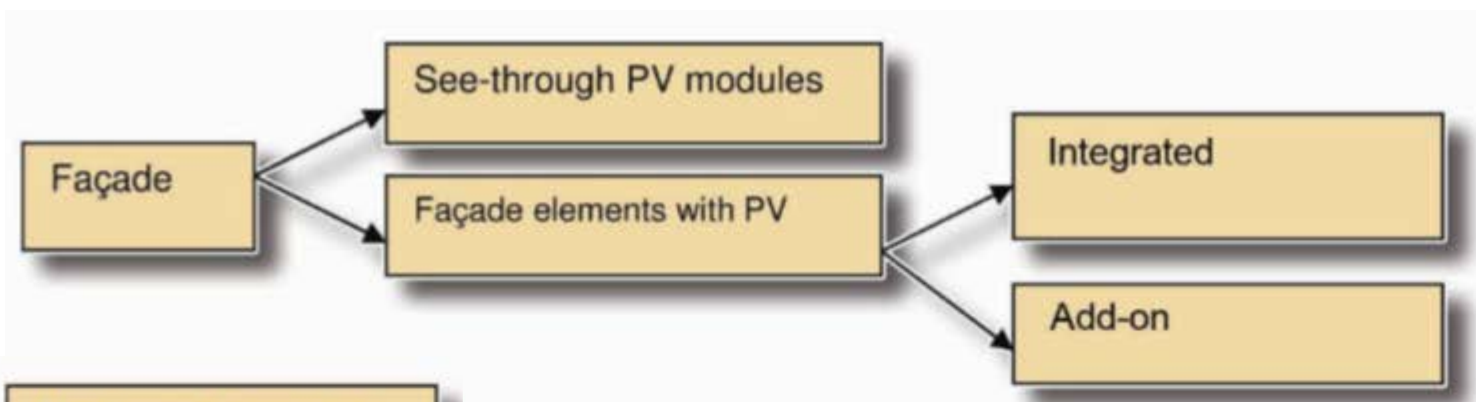
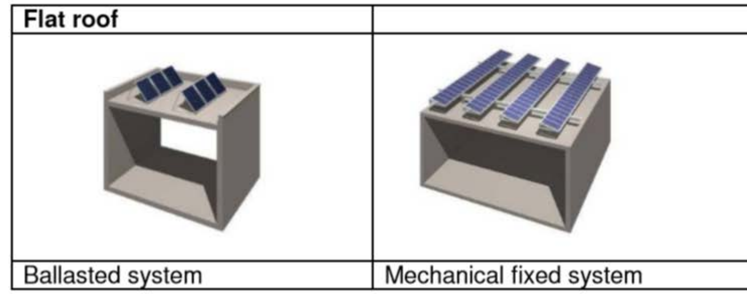


3) Shadowing elements

Implementation -
Flat roof

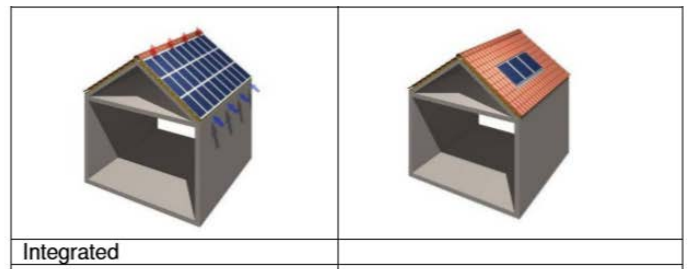
Found in the commercial and non commercial offices, warehouses and apartment buildings.
(*Structural Engineers*)

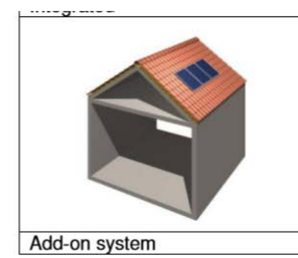


Implementation–
Pitched or sloped roof

The sloped roof applications are found mainly in the residential /commercial sectors.

(Architects, Structural & Electrical Engineers)



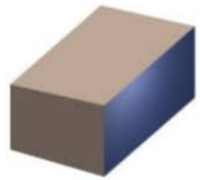
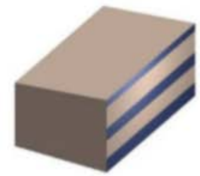


Implementation –

Facades

Found in the high-end architectural market segment.

(Architects, Structural & Electrical Engineers)

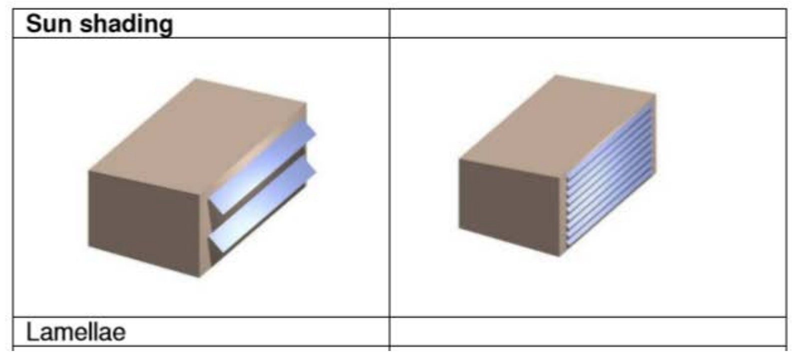
Façade systems	
	
Curtain wall, integrated	Parapet, integrated

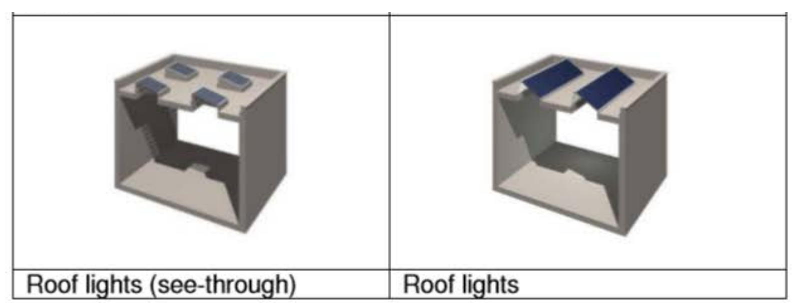
a. Facade

Implementation–
Sun shading

Sun shading is provided in various forms. *(Architects, Structural & Electrical Engineers)*

Sun shading

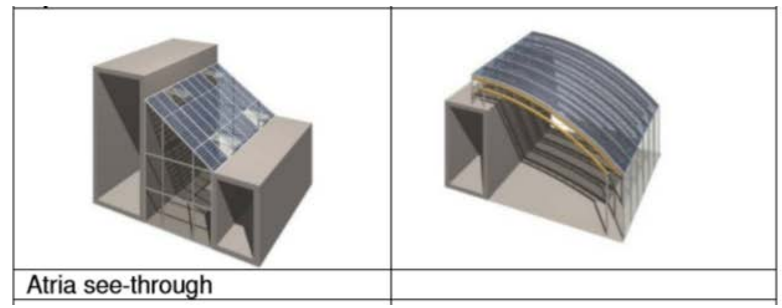


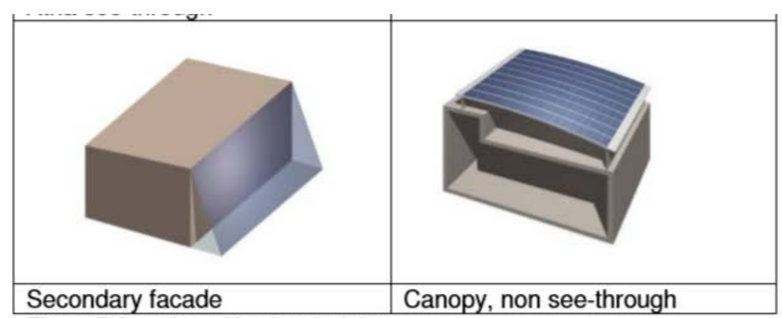


Implementation–

Specials

A special form of a flat roof system is flexible roofing material with PV.
(Architects, Designers, Structural & Electrical Engineers)

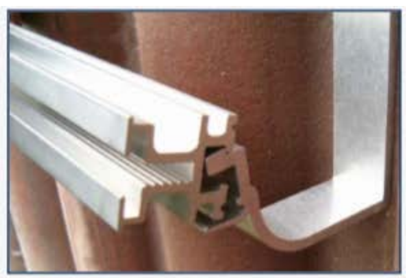




Mounting principles-
Sloped roof systems

The PV-System has to meet all the building codes.

(*Architects, Structural Engineers)*

– The appearance of the PV-System.

Mounting principles –
Sloped roof systems

- Roof hooks are fixed.
- A frame is placed on the hooks
- Standard PV modules are attached to the rail system with the use of special clamps.
- Wiring of the modules is done behind the modules and the DC cabling is fed through the roof

(Electrical , structural Engineers, Contractors)

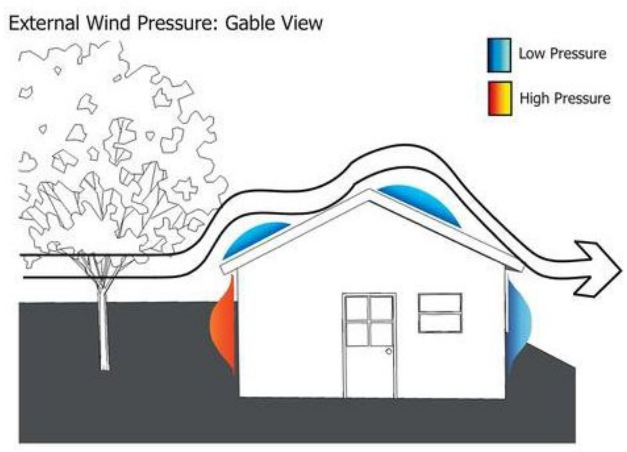





Safety
(Wind Loads)

Resistance to wind loads *(Structural & Civil Engineers)*

1. PV mounting systems should withstand wind-induced loads.
2. Additional loads or load concentrations should not exceed the structural capacity of the building.
3. ASCE Standard-7-05 is currently used.
4. Wind tunnel testing or computer simulations are sometimes used.



Safety

(Water tightness)

- The primary function of a roofing system is to maintain water tightness.

- The PV system should not compromise this.

Safety

(Electrical)

Operating temperature of the modules

a. Can cause a risk for connectors, cabling and plastic components.

b. The free space between integrated modules (the roof or wall surface) determines the convection and ventilation behind the modules.

c. Temperatures of 40 to 50 ^{o}C above ambient temperature can occur during normal operation.

d. This causes additional degradation of insulation materials.

(*Electrical Engineers, Contractors)*

Safety
(Electrical)

The PV-System has to meet all electrical codes.

(Electrical Engineers, Contractors)

- PV systems are subject to electrical faults:
  - arc faults
  - short circuits
  - ground faults
  - reverse currents
- These faults are usually caused by
  - cable insulation breakdowns
  - rupture of a module
  - faulty connections

Safety
(Electrical)

What is an arc fault?

- A high power discharge of electricity between two or more conductors.
- Happens when something occurs to interrupt the conductive path when current is flowing.
- Can be caused by:
  - Corrosion
  - Damaged conductors
  - Rodents
  - Loose terminals

Safety
(Electrical)

- Any disconnection or faulty connection of current carrying wire can cause an electric arc.
- An arc-flash can occur when there is sufficient amperage and voltage and a path to ground or to a lower voltage.
- Solar installations are particularly sensitive to this exposure
- **DC arcs do not self extinguish**
- Arcs can melt metal

Safety
(Electrical)

- *What is the intrinsic fire hazard of the photovoltaic system itself?*
- *What is the impact of a rooftop or wall mounted PV system in a fire situation?*
- *What steps can be taken to avoid or minimize or such incidences?*

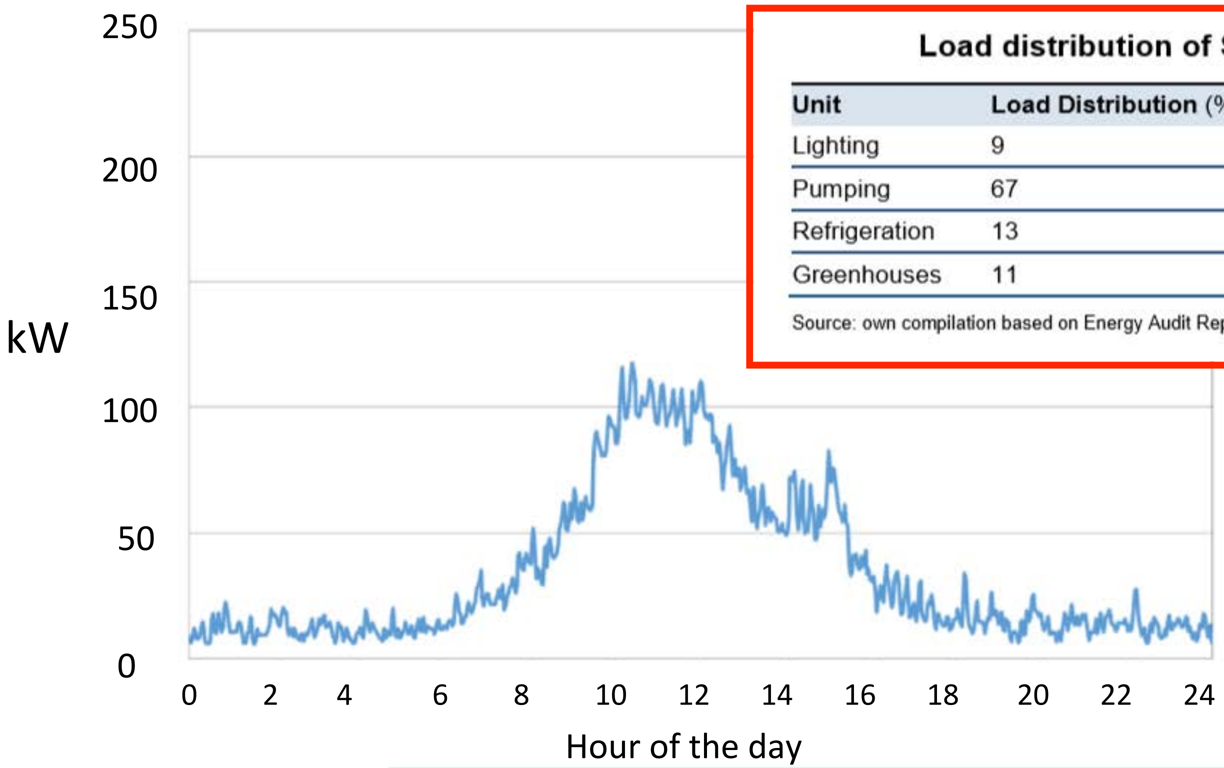
Safety

- Develop & Enforce National Standards.
  - Modules
  - Cables
  - Inverters
  - Mounting systems
  - Protective Equipment
  - Installation Standards (Wiring and Cabling)
  - Maintenance Standards
  - **Lifelong Training and Short Courses for stakeholders**
    - Architects, Designers, Real Estate Developers, Urban Planners, Engineers, Vendors, Contractors, Emergency Response units, Fire Fighters, Technicians.

Financial Incentive

- Net metering
- Peak load shaving

Daily load profile for Simbi Roses



Load distribution of Simbi Roses

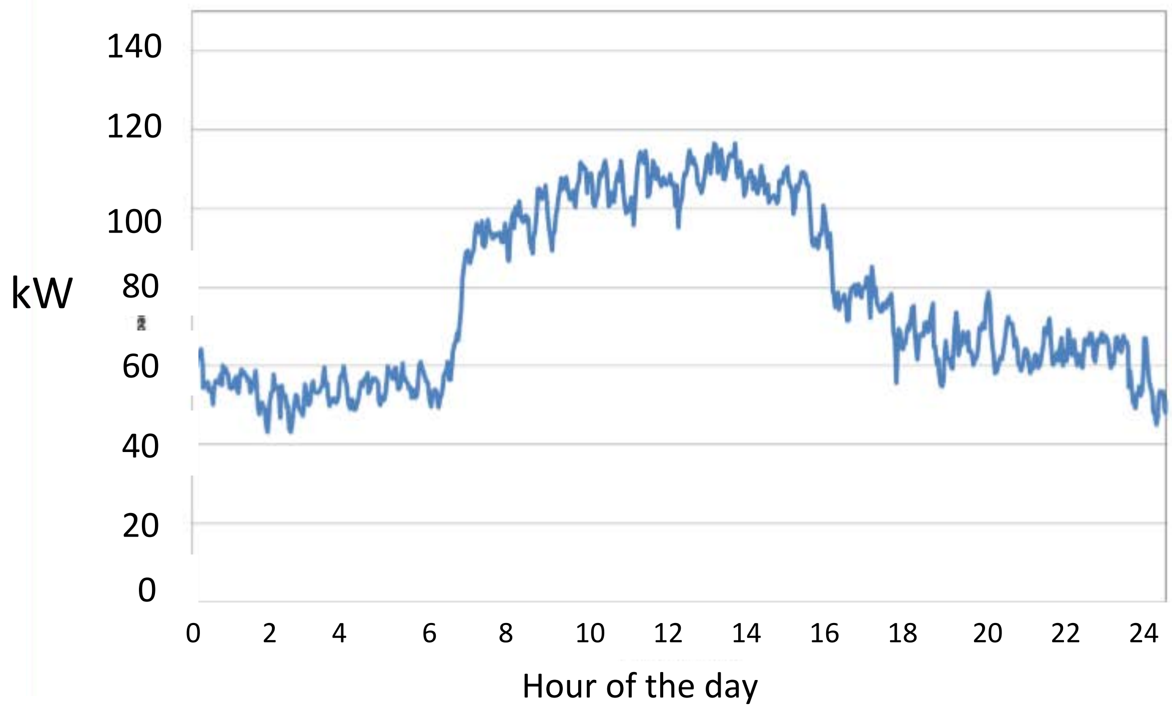
Unit	Load Distribution (%)
Lighting	9
Pumping	67
Refrigeration	13
Greenhouses	11

Source: own compilation based on Energy Audit Report., 2012 [5]

Picture courtesy of Uhuru Flowers, 72 KW

Financial Incentive

Daily load profile for Harvest Flowers



Pictures courtesy of Tambuzi Ltd, 60 KW

Financial Incentive

Overview of RE installations at flower farms

Flower Farm	Type of RE installed	Installed Capacity	Grid displace-ment	Developer & Installation	Financing	Commissioned
Uhuru Flowers	PV	72 kW_p	~30 %	Azimuth Power / East African Solar	Corporate finance	Feb 2013
Tambuzi Ltd.	PV	60 kW_p	~30 %	Chloride Exide	Corporate finance	Sept 2013
Timaflor Ltd.	PV (1-way tracking)	100 kW_p	n/a	Azimuth Power	n/a	2013
Olij Flowers	PV & Solar Thermal	100 kW_p & 180 m^2 thermal collectors	100 %	Van Zaal, Bosman Kenya Ltd., Hoogendoorn and Olij Flowers	n/a	Not commissioned by the time of writing
Bilashaka Flowers	Solar Thermal	n/a	n/a	n/a	n/a	2006
PJ Dave Ltd.	Biogas	125 kVA biogas generator	1.5 %	Pharma Engineers	1/3 corporate finance, 2/3 government grant	October 2013
Simbi Roses	Biogas	69 kVA biogas generator	0.9 %	Pharma Engineers	1/3 corporate finance, 2/3 government grant	May 2013

Conclusions

1. African HEI's should establish & demonstrate commercial/financial viability of own projects.

Solar analysis and projections

No.	Baseline Parameters	Value
1	Average energy consumption before installation of the solar PV system	**22,492.50 kWh**
2	Average energy consumption after installation of the solar PV system	**16,257.25 kWh**
Other Parameters for Analysis		
3	Average monthly energy savings with installation of the solar PV plant	**6,235.25 kWh**
4	Percentage savings (%)	**30%**
5	Monetary savings (monthly)	**KShs 130,940.25**
6	Monetary savings (annual)	**KShs 1,571,283.00**
7	Expected payback period (years)	**7.64**

2. Develop electives, certificate, and diploma courses as "spin-offs".

Thank you