IOREC: International Off-Grid Renewable Energy Conference & Exhibition
Nairobi, Kenya
30 September - 1 October 2016

Economics of rural Microgrids

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Trama TecnoAmbiental (TTA)

- SME Founded in Barcelona en 1986
- Independent consultants in distributed renewable energy
- Consultancy, engineering, research, project management, social aspects, financial, …
- Since 1987: PV electrification practitioners
- Design and project management of RE-hybrid power plants and micro grids for rural electrification
- Southern Europe, Africa, Latin America, Oceania …
- Public, private and multilateral clients

Member of:

Alliance for Rural Electrification

solartys

UNEF

MGS Background

Akane (Morocco)

Santo Antâo (Cape Verde)

3 villages (Chad)

Burundi

Isla Floreana (Ecuador)

Cal Peraire (Spain)

Escuain (Spain)

La Rambla del Agua (Spain)

Diakha Madina (Senegal)

Beni Said (Morocco)

Las Balsas (Ecuador)

Atouf (Palestine)

4 villages (Ghana)

2002 2005 2006 2007 2009 2012 2013 2014 2015 2016

1997

1994

Tanzania Rwanda and Kenya

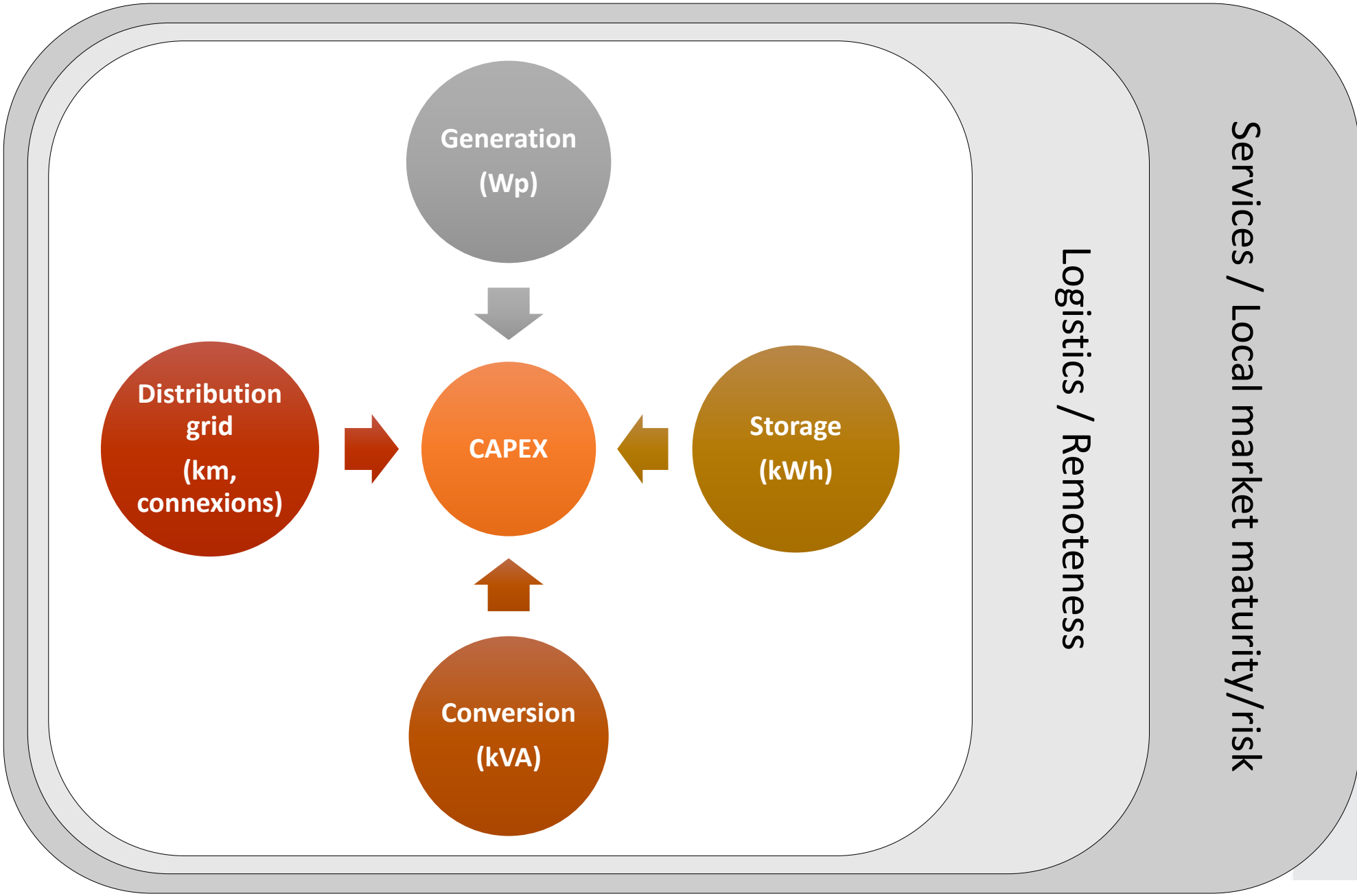
1987: Beginning *Farmhouses PV electrification (Spain)*

Factors affecting hybrid microgrid costs (< 1 MW)

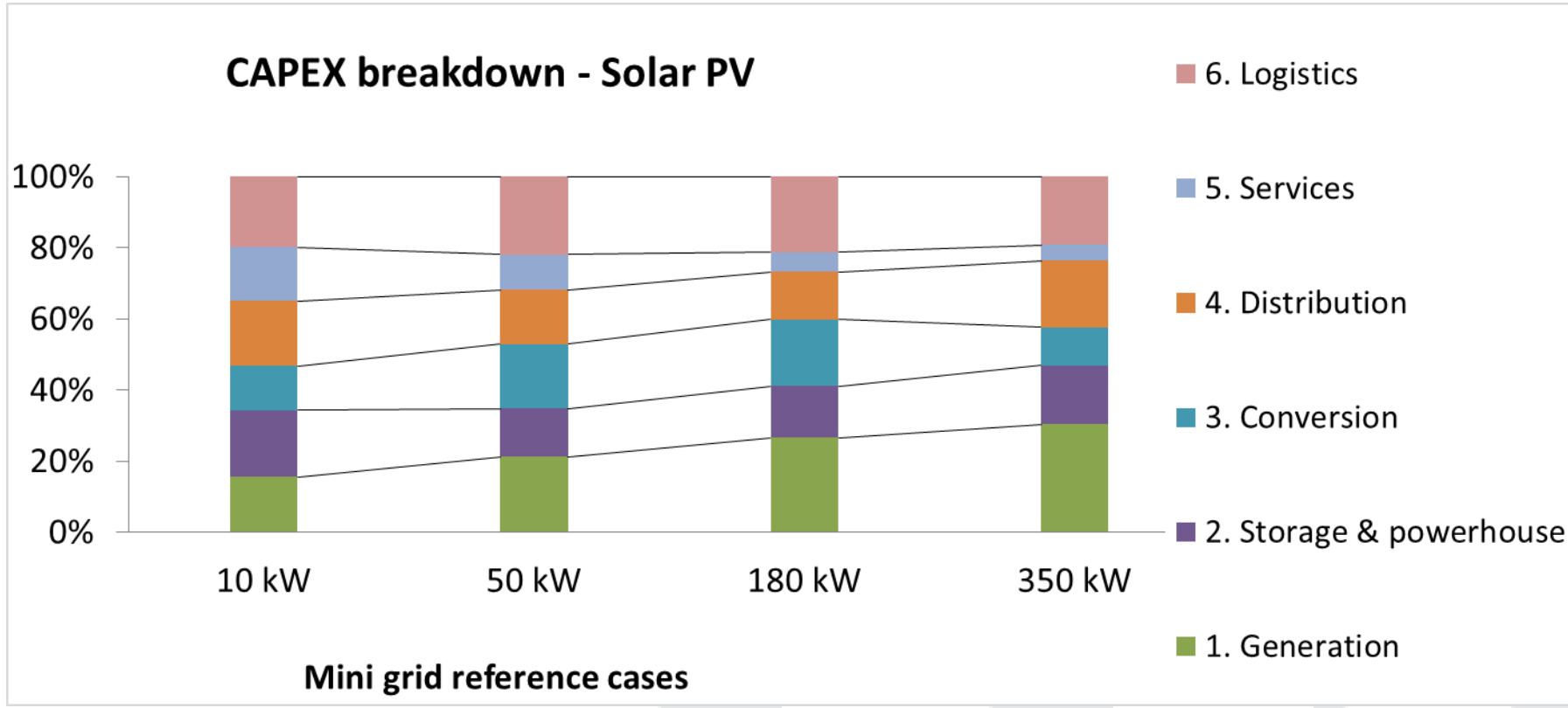
- Grid connected vs autonomous
- Economies of scale
- Demand, load profile and RE sources => engineering design
- Quality of service – ie Tiers ESMAP
- Market maturity
- PV fraction:

Category	Indicative PV annual energy fraction	Indicative PV rated capacity/load ratio	Characteristics
Low	< 20%	< 50%	No batteries No control
Medium	20%-50%	> 50%	Batteries with autonomy 1-2 days Large genset
High	> 50%	> 150%	Batteries with autonomy > 2 days Small gensets

Cost structure – capital costs



CAPEX according to capacity



Source: ECA, TTA, Access Energy, 2014

Operation

Fixed O&M costs

Component	Description	Comments/Differentiating Factors
Personnel (administrative and technical staff)	Salaries for manager and technical operator Security guard	Depends on the management scheme
Billing costs	Administrative cost of billing consumers	Depends on tariff structure (energy, flat rate, periodicity, etc)

Variable O&M costs

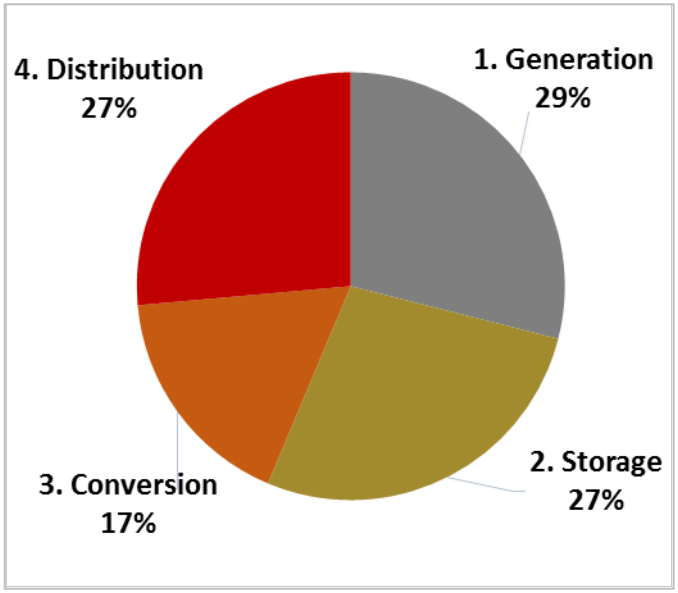
Component	Description	Comments/Differentiating Factors
Replacements and spare parts	Equipment that needs to be replaced during the lifetime of the project and equipment for minor reparations	stock availability, equipment lifetime, quality of operation
Fuel	Fuel consumed by back-up diesel generator	Depends on plant design and operating conditions (demand, RE resources)

CAPEX breakdown

Category	Unit
1. Generation	
PV modules (incl. structure & cabling)	kWp
Wind turbine incl. Tower	kW
Hydro turbine incl. Penstock and civil works	kW
Regulators (incl. protections)	kW
Labour	*% category*
2. Storage and powerhouse	
Battery (incl. cells, cabling, protections)	kWh
Monitoring and control system	unit
Technical room (powerhouse with fence)	m^2
Labour	% category
3. Conversion	
Battery inverter incl. cabling	kVA
Genset	kVA
EMS Energy Management System	unit
Labour	*% category*
4. Distribution	
LV distribution grid (incl. poles, cabling and protections)	m
MV distribution grid	m
Transformers	kVA
Public lighting	pole
Smart meters, service connections, internal wiring	# customers
Labour	*% category*
5. Services	
Project Management and engineering	Market maturity
Capacity building (technicians and beneficiaries)	Market maturity
6. Logistics	
International shipping costs (maritime), incl. customs	Miles from port of departure
Local transportation costs (road)	Km from port of destination
Storage of equipment	% CAPEX
Insurance , security staff	% CAPEX

Case study – Pediatorkope (Ghana)

CAPEX



Logistics

€5 per mile of maritime

€61 per km of terrestrial

Services

Project management and engineering: 10% CAPEX

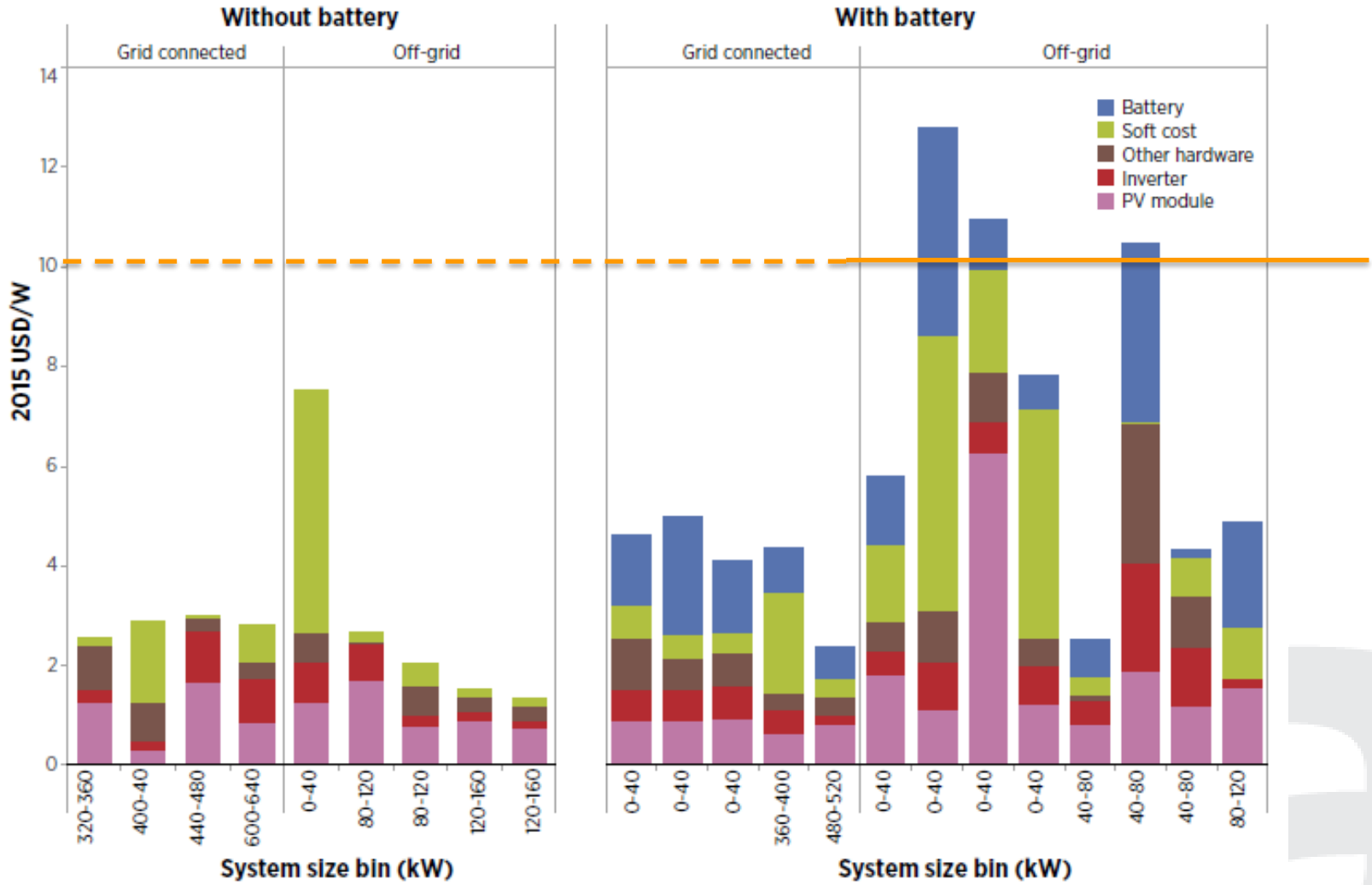
Capacity building & Training: 3% CAPEX

Low maturity market

Not per kWp!

Study on microgrid costs

FIGURE 30: SOLAR PV MINI-GRID TOTAL INSTALLED COST AND BREAKDOWN BY COST COMPONENT, 2011-2015



Ghana

Note: All system sizes have been rounded.

IRENA, 2016

Financial – Economic component → Viability!

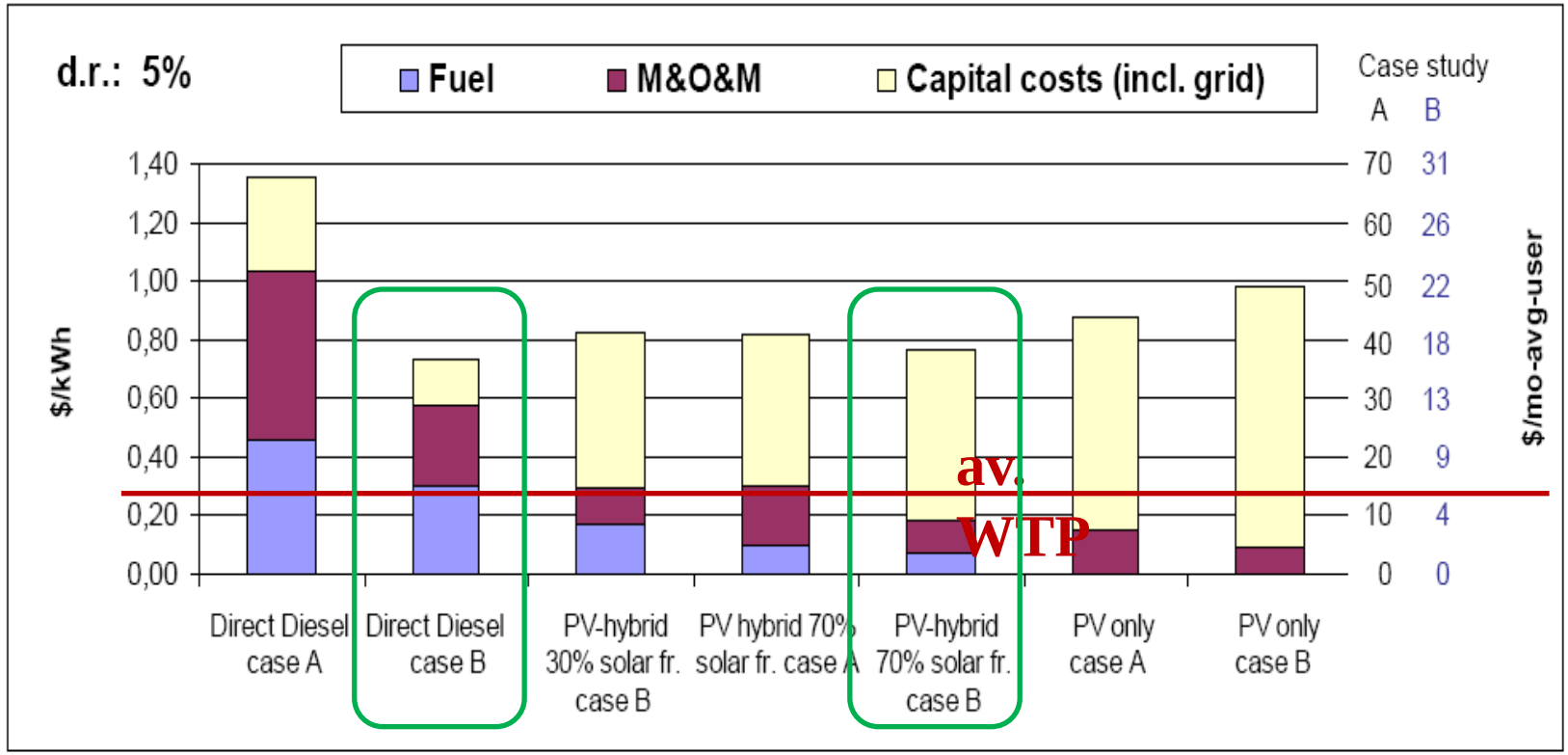


Figure 3.- Breakdown of levelized energy costs in Floreana (case A) and Padre Cocha (case B) at 10% and 5% discount rates. Average kWh cost are acceptable to compare different solutions for one application, but for different systems for different locations and small demands, transaction costs, local management, etc, represent a high fraction of the service costs, and the cost per user must also be assessed.

Source: Arranz-Piera, P. Vallvé, X., González, S. (2006)

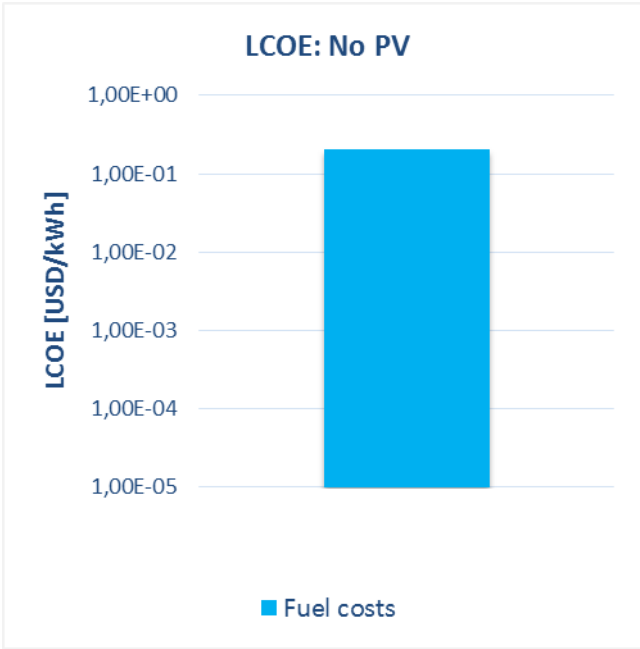
Tariffs in Ghana: cost reflective vs grid (2016)

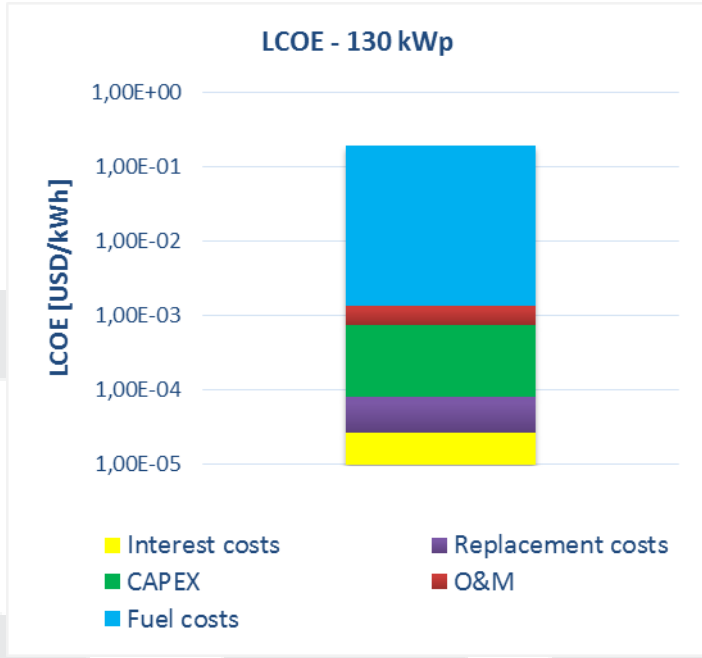
Tariff tier (residential)	**EDA (Wh/day)**	**Power (kW)**	**Willingness to Pay tariff - O&M and 25%CAPEX (GhS/kWh)**	**Cost reflective tariff - only O&M (GhS/month)**	**Grid tariff (GhS/month)**
T01	275	0,5	18	10.0	4.2
T11	550	0,5	30	20.0	6.9
T21	1100	0,5	52	40.2	12.3
T31	1650	0,5	74	60.2	17.7
T42	2200	1	100	8.3	33.6
T53	2750	1,5	120	100.4	44.7

Brownfield project: case of a factory (Lebanon)

Intermittent grids: Gensets as backup

Hybridisation of a juice factory with 130 kWp






THANK YOU!
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