

“RERIS.III.2 – DECENTRALISED RENEWABLE AND HOUSEHOLD ENERGY SOLUTIONS III”

“Dynamics of Solar markets in Subsaharan Africa“

1. Introduction

The African power market is facing several issues:

- Low rate of electrification 612 million
- Old and badly maintained infrastructure (grid, power stations, substations)
- High grid losses 12%
- Frequent power outages 8,6h/month
- high power prices 0,15 US\$/kwh
- Insufficient investments in the face of increasing power demand

Challenges of the Power Market

1. Can Solar power contribute to solve the issues of the power market in Subsaharan Africa?
2. Should Solar power and other RE be used to solve the issues of the Subsaharan power market?
3. **Are the markets of Solar Power technologies developing in a way that significant contributions can be expected during the next 10-12 years?**

2. Progress in Electrification

People without access to electricity, worldwide

2000: 1,7 billion

2015: 1,1 billion (success story India: 500 million)

In Sub-Saharan Africa electrification rate rose

2000: 26,5%

2014: 37,4% (69% urban; 18% rural)

South Asia (India, Bangladesh, Vietnam, Indonesia...)

2000: 57,1%

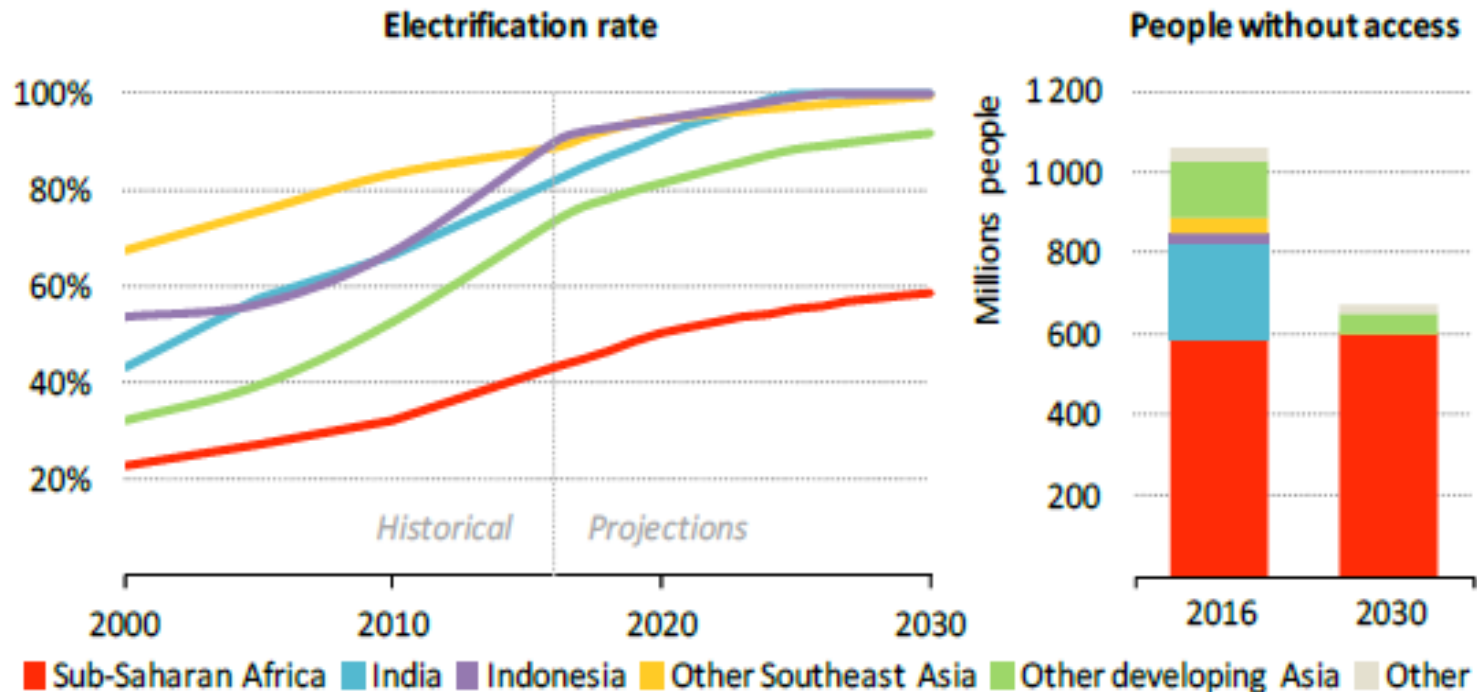
2014: 80,2%

People with and without Electricity in Sub-Saharan Africa 1990 – 2014 (millions) (Worldbank Databank)

	1990	2000	2010	2014
Electrification rate	23,40%	26,60%	32,20%	37,40%
Population (million)	511	670	877	978
with acces	119	179	282	366
without access	392	492	595	612
Av. Increase of population p.a.		15,9	20,7	25,3
Av. Increase connections p.a.		6	10	21

- Number of people with power access has risen by 207% (1990-2014)
- No. of people without power access has risen by 56% (1990-2014)
- Increase of number of people without power access is slowing down from decade to decade

Electricity Access rate and people without electricity



By 2030, nine-out-of-ten people without access are in sub-Saharan Africa

Note: Other includes Middle East, Latin America and North Africa.

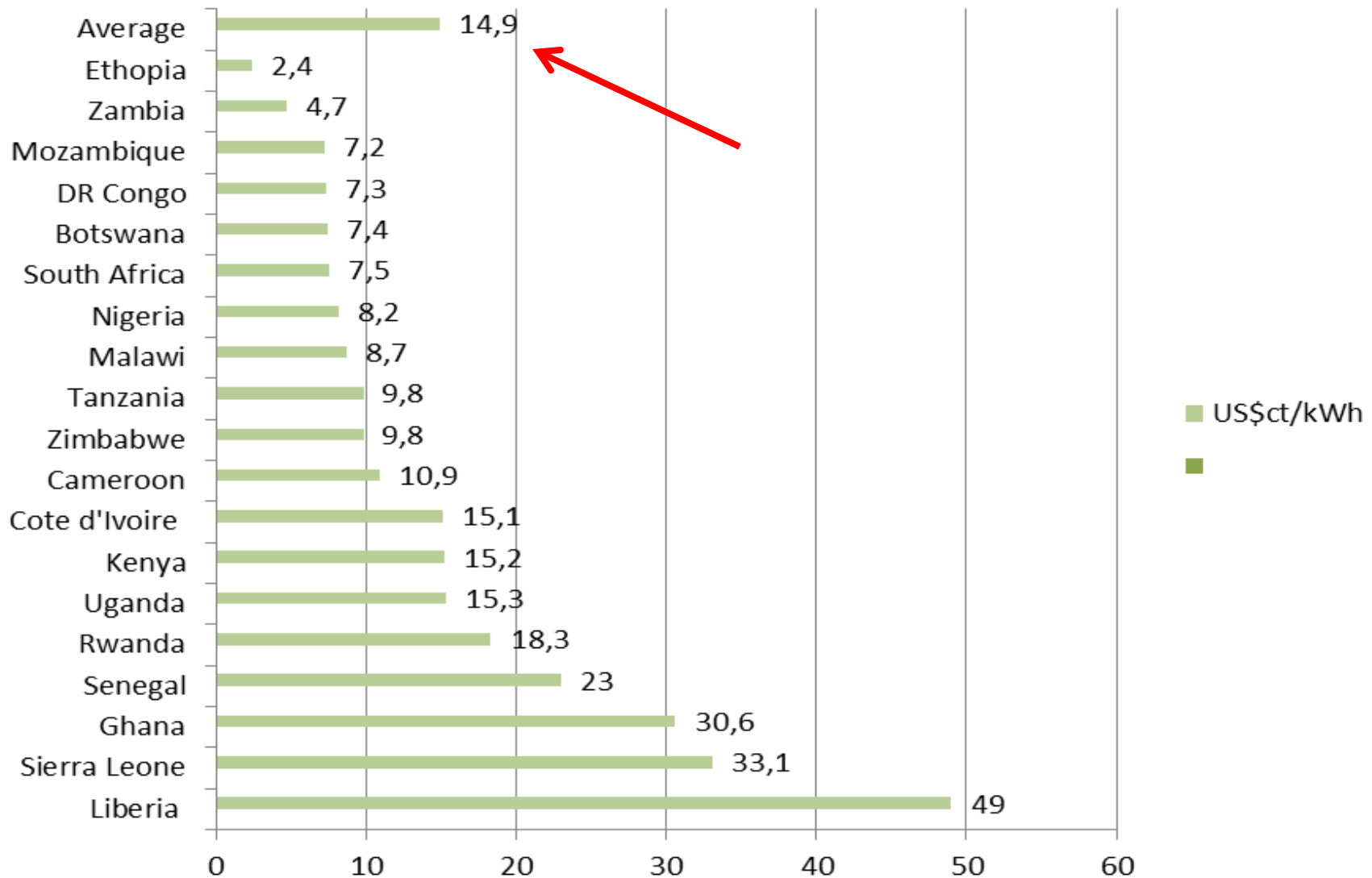
Source: IEA 2017, p.48

Challenges of the African power sector

South-Asian electrification miracle

Subsaharan African electrification drama

Average Retail Price 2016 in US\$ Cent in selected Susaharan Countries



Number of Power Outages for Firms in typical month

Benin	2016	28
Cameroon	2016	7,6
Congo Kinshasa	2013	12,3
Cote Ivoire	2016	3,5
Ethiopia	2015	8,2
Ghana	2013	8,4
Nigeria	2014	32,8
Senegal	2014	6
Sudan	2014	3,4
Tanzania	2013	8,9
Togo	2016	5,5
Subsaharan Africa	2016	8,6
South Asia	2016	25,5
Source: World Bank		

Electric Power Transmission and Distribution Losses – percent of output -

Country	1990	2014
Angola	25	11
Ethopia	10	18
DR Congo	20	21
Kenya	15	18
Namibia	n.a	36
Nigeria	38	16
Senegal	17	13
South Africa	6	8
Sudan	15	14
Tanzania	20	18
Togo	21	73
Zimbabwe	7	16
Subsaharan Africa	9	12
World	8	8
Source: World Bank		

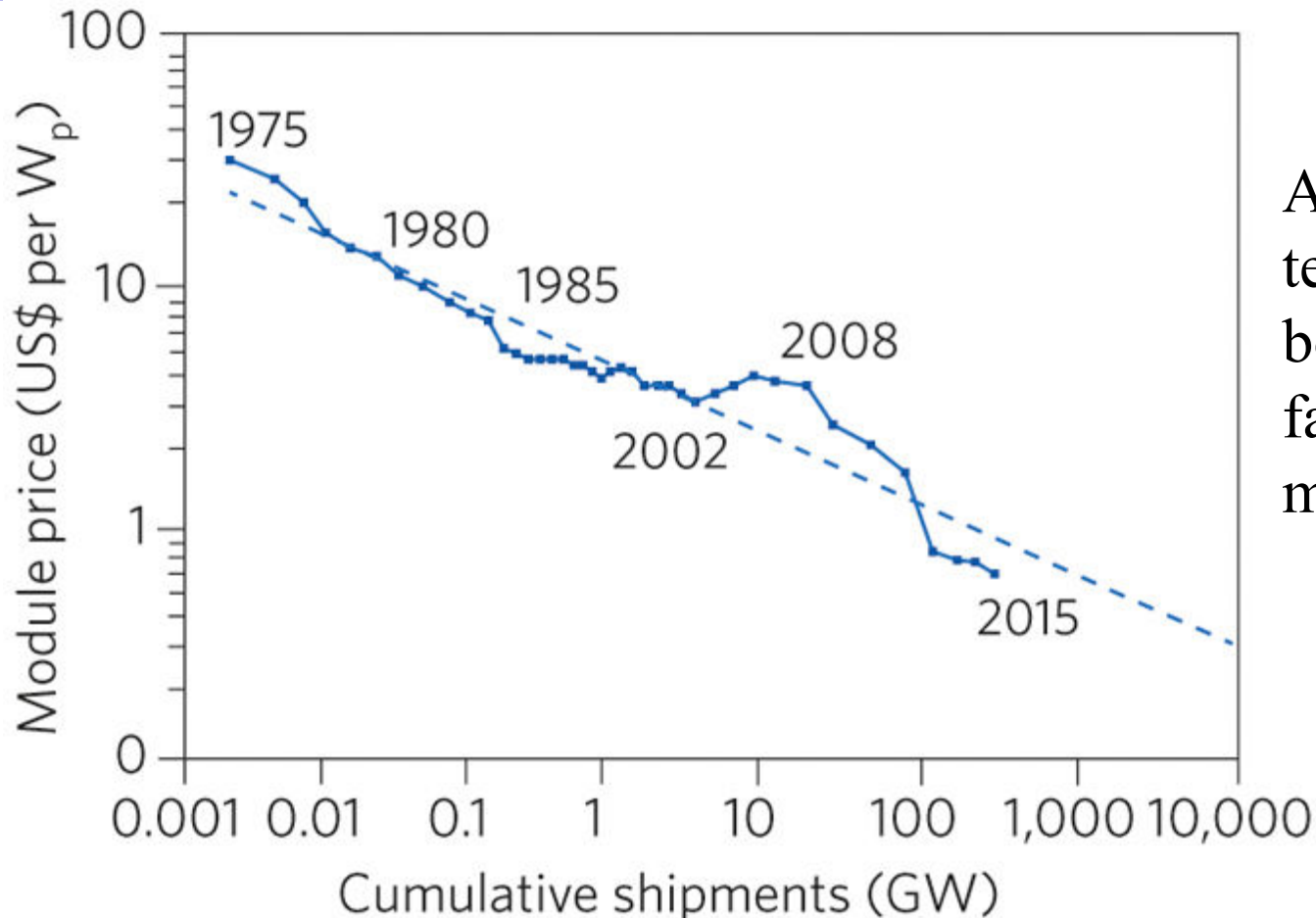


3. Are PV-Technologies market developing in the right direction to solve the problems?

3 types of PV technologies:

- | | |
|---|--------------|
| I. <u>off-grid</u> technologies | typical size |
| a. Pico PV: | 1 -10 W |
| b. Solar-home-systems | 10-200 W |
| c. Commercial | 200-1000W |
| d. Mini-grids | 10 KW – 1 MW |
| II. <u>On-grid</u> Utility scale plants | > 1 MW |
| III. <u>On-grid</u> roof-top | |
| I. Households for own consumption | 1- 10KW |
| II. Industry: Own consumption/Back-up | 10-500KW |

Historical learning curve for PV modules



All PV technologies benefit from falling module prices

Market 1 – Pico PV

- Pico PV Market is rapidly developing (no more donor dominated)
- Prices for solar lamps came down to 10US\$ or less
- The payback period is short (several months)
- Diffusion of Pico PV – strong regional differences
 - East Africa (Kenya, Uganda, Tanzania)
 - North Africa (Algeria, Morocco)
 - South Africa
- In Africa about 20 million households (100 million people) make use of Pico PV (Kenya 1 of 3)
- **IEA: Pico PV services under threshold of energy**

access (IEA 2017,p.22)



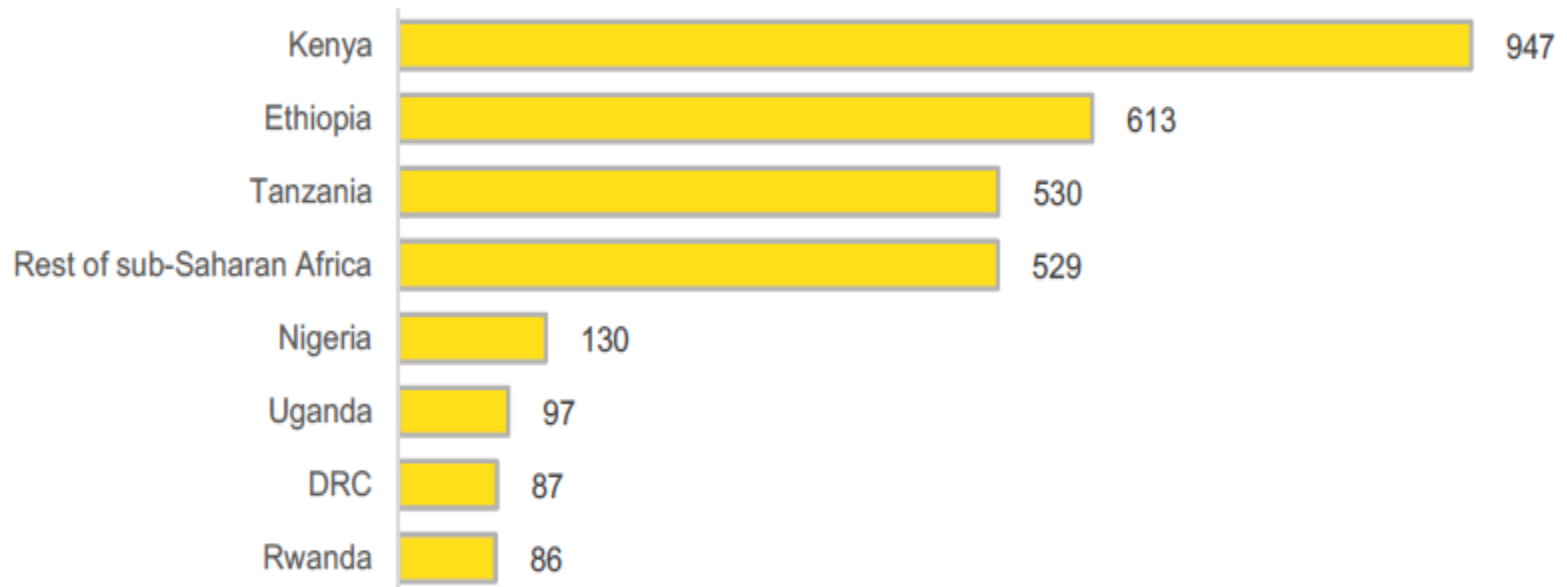
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Reported sales of Lighting Global quality-verified pico-solar products in sub-saharan Africa, in thousands (mid 2014- mid 2015)



(Off-grid-Solar Market Trend
Report 2016, p. 12)

Market 1 – *Solar Home Systems*

While the Pico PV market is very big market (5 million branded unit in Africa)

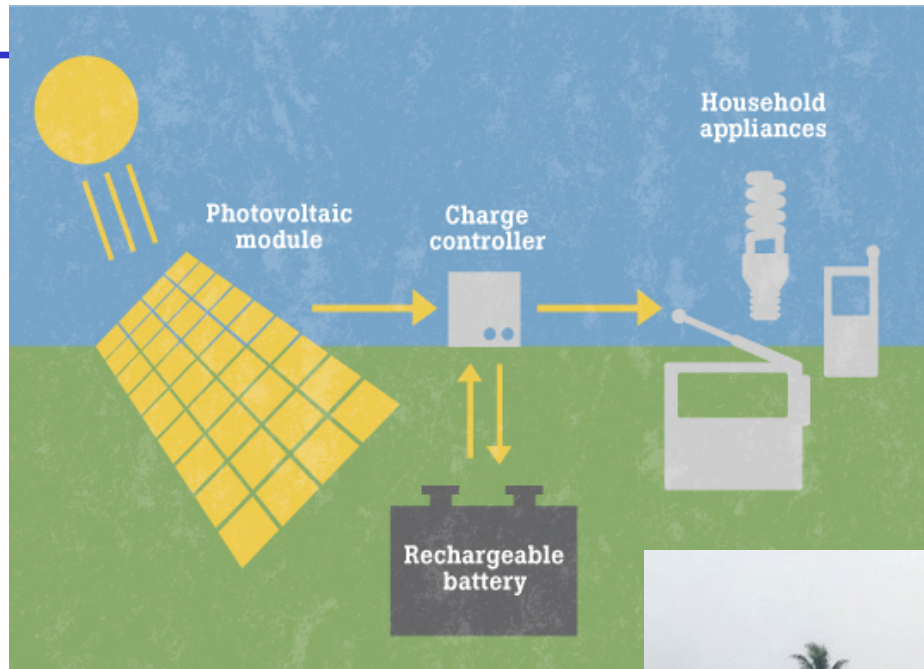
The Market for SHS > 10 W is much smaller: 2015 worldwide ~ 200,000 units sold (Bloomberg, 2016, p.14)

Today: Kits instead of seperated components

Quality improved

With a 100W kit: multi LED, Cellphone charging, Radio, TV, fan (**energy access**)

Solar Home System



Solar home systems in
Nigeria (200-300W)



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Market 1 - Solar home systems

What are the reasons for the small diffusion of SHS?

Reasons:

- High Upfront Cost: System cost of 5-10 US\$ per Watt (100 W = 500 -1000 US\$) still not affordable for many households (IRENA 2017)
- Financing-schemes: Loans and Pay-as-you-go systems are help, but not only in few countries available
- Reliability: was very bad in the past, improved by standards today
- Service: a challenge in remote areas with bad infrastructure
- Image: „second class electrification“, „technology for the poor“

Model: Morocco: Utility led rural electrification - Provision of PAYG-service by National power company

Solar home systems

Besides these obstacles the off-grid approach has another disadvantage: **it does not lead to a national PV-markets**

All **lamps** are just imported from Asia and sold by ware-houses and other retailers

The **market for SHS** is too small to attract (international) capital

Calculation:

$$100 \text{ W} * 50,000 \text{ units per year} = 5000 \text{ kW or } \mathbf{5 \text{ MW/a}}$$

Market 1 - Off-grid Capacity 2007-2016 in MW (cumulated)

Off-grid Capacity in MW		
	2007	2016
Algeria	2	225
Egypt	1	39
Morocco	12	21
DR Congo	6	6
Kenya	9	26
Nigeria	0	19
South Africa	17	70
Uganda	8	24
Africa	72	649
Asia	0	632
World	87	1368
Source: IRENA, 2017, p.45		

Capacity in Sub-Saharan
Africa without South-
Africa: **300 MW**

Market 2 - Utility Scale PV plants

Utility scale PV plants have 2 properties

- They produce power for the national grid (sold via PPA)
- Certain size ($> 1\text{MW}$)
- Realization by IPP within a competitive bidding process

Precondition for the success of utility scale PV plants

- Power market reforms (access of IPP) and
- the fallen prices of PV technologies
- Favourable financing conditions for large projects
- Interest of international investors in large projects

Market 2 – large plants

Hundreds of projects seem to be in the pipeline

But if you look to operating plants

80% in 2 countries: South-Africa, Algeria

Of the 50 biggest operated plants in Africa (> 1 MW) only 8 are located in Subsaharan Africa (like **Ruanda, Namibia, Kenya and Ghana**).

Ostacles: Lacking regulatory framework, financing EPV or BOOT, political issues, local content requirements, Lacking power lines

Top 50 Operational PV Plants in Africa 2017

Country	Number of plants	
South Africa	29	
Algeria	12	
Ghana	2	Capacity in Subsaharan Africa without South Africa: <60 MW
Namibia	2	
Egypt	1	
Ruanda, Kenya	1, 1	
Mauretania , Cap Verde	1. 1	

Source:<http://africa.unlockingsolarcapital.com/top-50-pv-plants/>

Utility scale PV power plants >4 MW 2015 by continent

Continent	Projects number 2015 and additions 2016		Capacity MW AC
Africa	47	+1	1,856
Asia	1,127	+197	27,596
Australia & Oceania	4	+4	159
Europe	1,347	+254	13,984
North & Central America	825	+ 85	15,310
South America	32	+ 4	1,151
World total	3,382	+ 544	60,267 (73600)

SA: 32 plants with 1392 MW

Source: Wiki-solar

Market 3 : Rooftop-Plants medium size

Here we talk about 0.5 KW – 500 KW....installed on grid connected buildings.

- Plants for self-supply (in case of high power prices)
- **Back-up systems** in case of power cuts (with battery)

Demand comes from industry, supermarkets, clinics etc.

The market is growing (SA 200MW, Ghana, Namibia); but its dynamic is strongly depending on the regulatory framework. If excessive power cannot be fed in to the grid, the plants remain small. Positive:

- High power prices, progressive tariffs
- Net-metering, feed-in tariffs

PV – grid connected



Ghana

2011: 450 plants



Market 3

- When power prices increase ... the market will occur!
Its there....no data available!!
- Not automatically: Regulatory framework is important
- Import tolls for PV technologies and batteries
- Power purchase conditions must be clearly defined
- **The market is driven by well-funded investors (firms, households), not by donors or politicians**
- **It can be expected that this market will grow more rapid than other markets and best suitable to establish a national PV industry**

Market size of different PV markets in Africa (in MW)

	South Africa	North Africa	Subsaharan Africa
Market 1 Off-grid	70	285	300
Market 2 Utility scale	1400	450	60
Market 3 Rooftop on-grid	200	n.a.	n.a.

Thank you for your attention!