Solar Home System – Uganda

Tarfaya Wind Farm – Maroc

Bart BOESMANS, COO & CTO ENGIE Africa

Bauchau Prize, Louvain-la-Neuve, April 16th, 2018

Technological & business opportunities and challenges in Africa

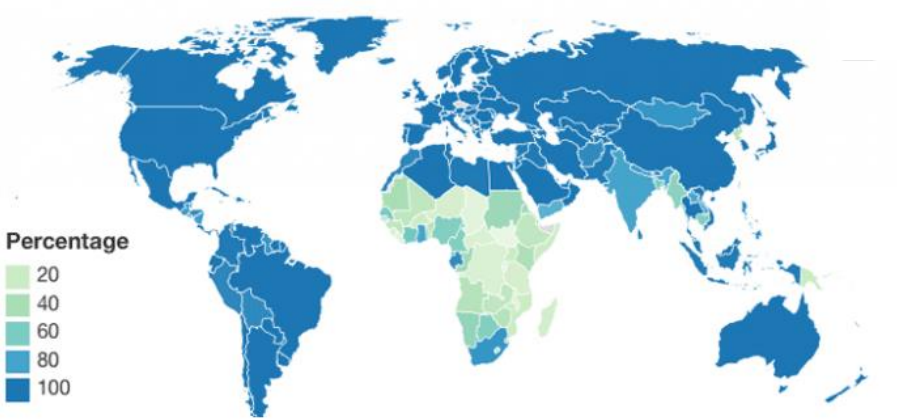
Energy Services, Renault – Morocco

www.engie-africa.com/fr

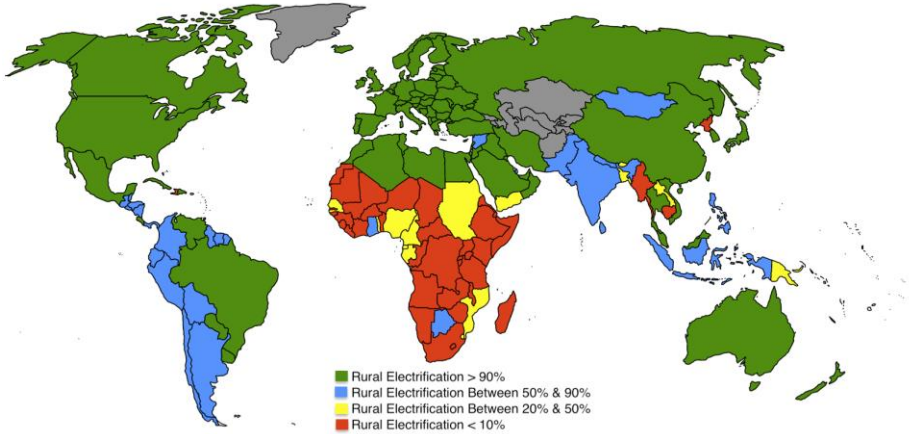
Power Corner Mini-Grid- Tanzania

Africa needs electricity …

World Map of Electrification rate



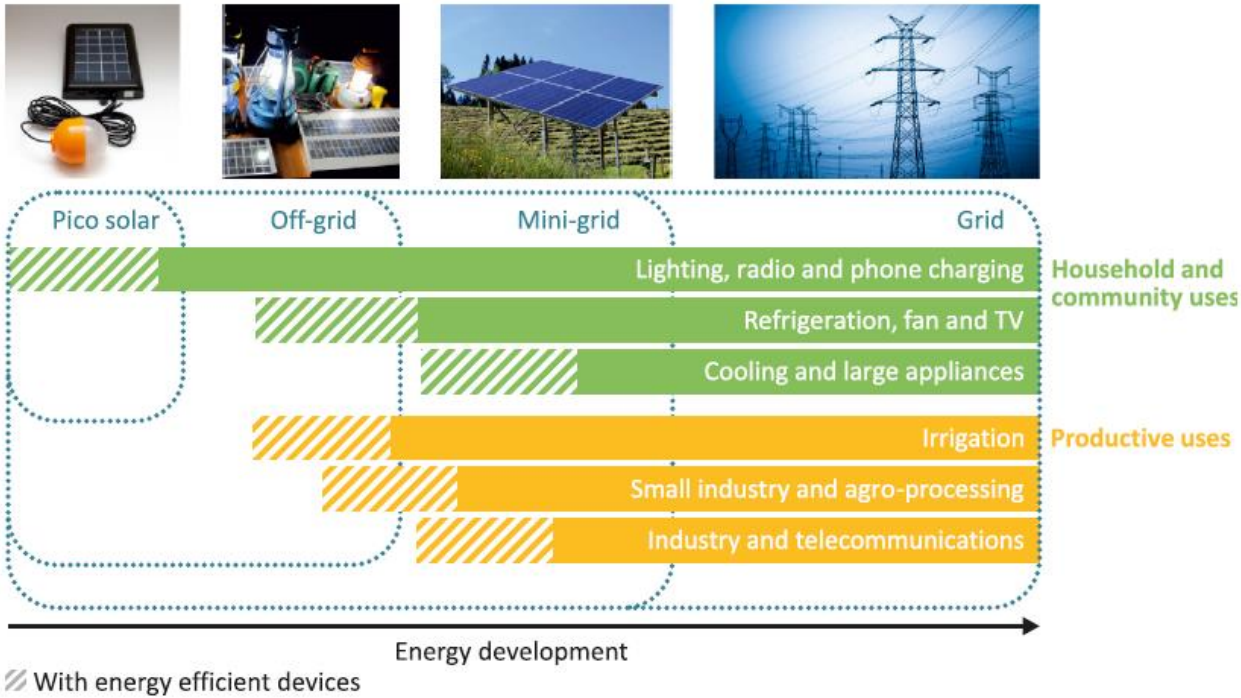
World Map of Rural Electrification rate



Electrification of Sub-Saharan Africa, **access to safe and reliable energy**, is an issue for **urban, peri-urban and rural populations**

Sources : World Development indicators

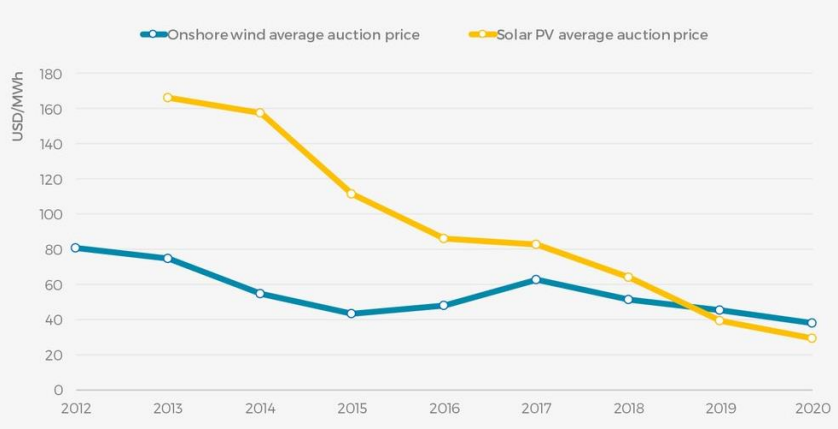
… and adequate Energy Solutions are available: diversity of technologies, different scales for different uses, corresponding to different business models



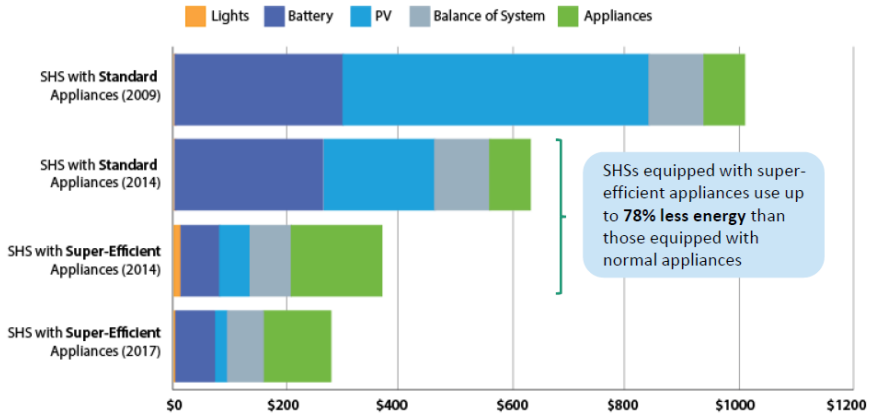
Sources : IEA World Energy Outlook 2017, special report, energy access outlook

Affordable & Clean Energy for a connected Africa … yes, today it is possible

Announced wind & solar PV average auction prices by commissioning date (2017)



Solar home System purchase price per type of appliance



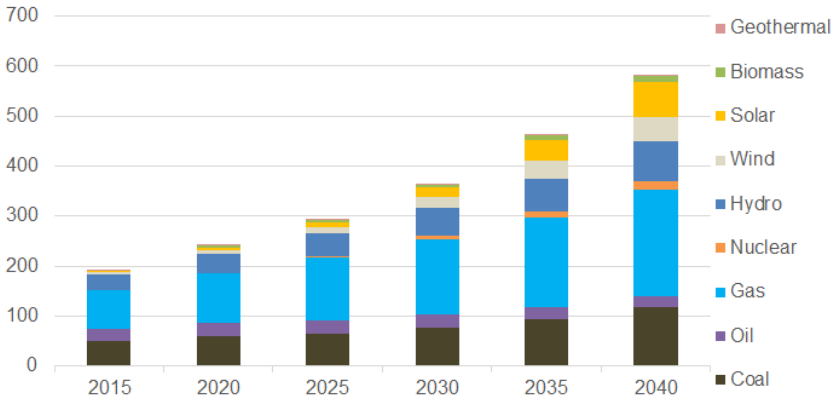
*Systems provide energy for 4 lights, a 19" color TV, a radio, and mobile phone charging
* Appliance use assumption: lights = 4hrs/day, TV = 3hrs/day, radio = 6hrs/day, mobile phone = 1 charge per day

Beyond the **drop in costs of clean technologies**, international institutions have taken the measure of the **urgency of electrifying Africa,** setting up **development and financing programs** and African governments have become aware of the **impact of climate change**,

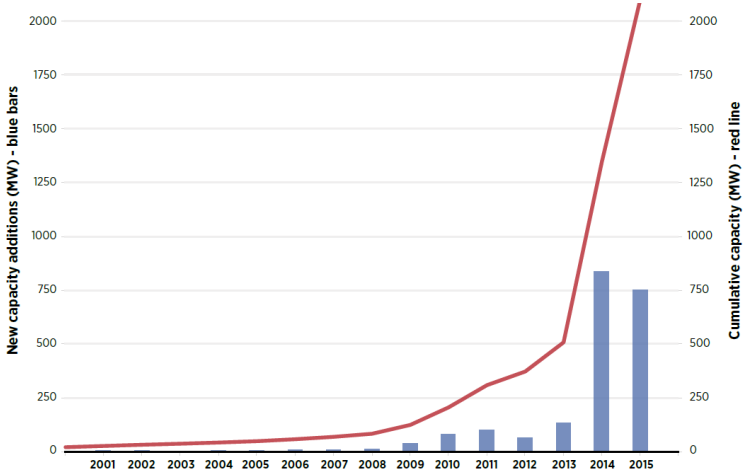
Sources : IEA, *Phadke, et al., "A Home Energy System in just 25 Watts: Super-Efficient Appliances Can Enable Expanded Energy Access Using Off-Grid Solar Power Systems"*

Centralized Energy in Africa: an evolution that reflects availability and cost of the resources, as well as geo-politic challenges

Africa Installed Capacity Forecast by fuel



Africa's total cumulative installed capacity of solar PV, 2000-2015



Beyond the diversity of energy sources in the 54 African countries, a common trend shows more and more penetration of **renewable energy and natural gas**

Sources : Enerdata, enerblue scenario / IRENA, 2016a

The development of Centralized Renewable Energy requires new (and affordable?) solutions to address intermittence

GENERATION

RES - INTERMITTENCE

THERMAL - FLEXIBILITY

STORAGE

ENERGY MANAGEMENT SYSTEM

Electrical energy storage systems

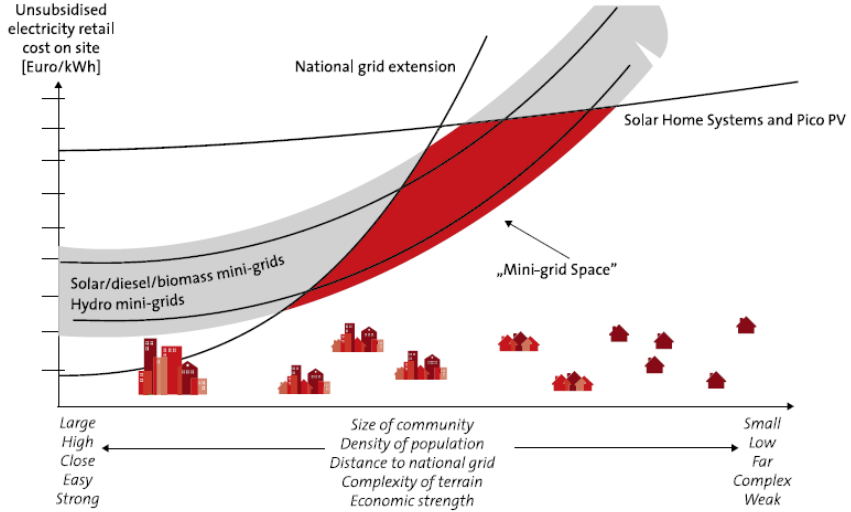
- Mechanical
  - Pumped hydro - PHS
  - Compressed air - CAES
  - Flywheel - FES
- Electrochemical
  - Secondary batteries (Lead acid / NiCd / NiMh / Li / NaS)
  - Flow batteries (Redox flow / Hybrid flow)
- Chemical
  - Hydrogen (Electrolyser / Fuel cell / SNG)
- Electrical
  - Double-layer Capacitor - DLC
  - Superconducting magnetic coil - SMES
- Thermal
  - Sensible heat storage (Molten salt / A-CAES)

In addition, investments in **Transmission, Distribution & Interconnection** are urgent to meet existing demand and absorb the expected growth

Sources : Engie, IEC.ch

Mini-Grid solutions are competitive with grid extension depending on density of power consumption and its distance to grid.

Illustrative the mini-grid Space



Global Cost of electricity generated by mini-grid systems (2015)

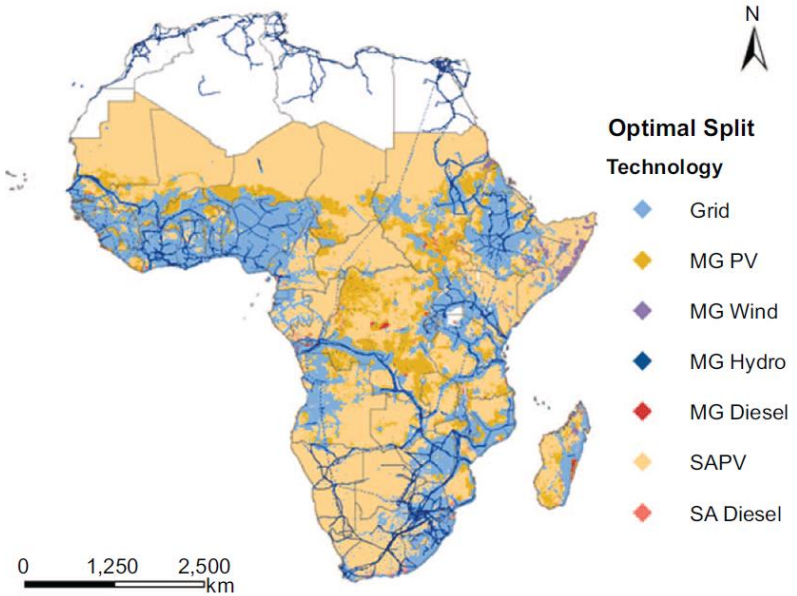
Mini-grid solutions allow electrification of entire communities with a single project and provide **flexibility** to **scale up or connect** with the grid at a later stage

The **drop in solar PV and battery costs**, and of other mini-grids solutions will offer more important economic opportunities in the coming years

Sources : Inensus, Clean Energy Ministerial (2014)

Different technologies of Mini-Grids, and a big potential for Solar PV in Africa

Estimation of spatial electrification optimization in Sub-Saharian Africa



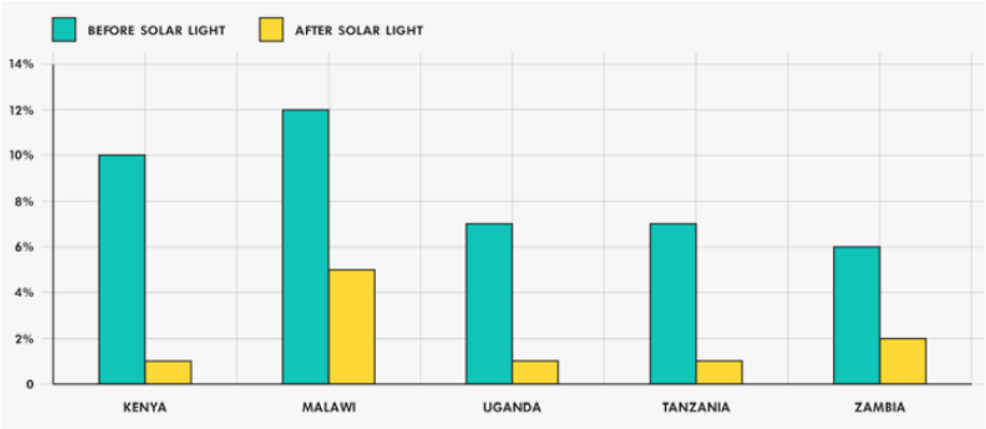
Advantages and Limitations of different technical solutions

Micro/mini hydro	Solar-battery	Solar-battery + diesel	(solid) Biomass gasifier	Wind-battery	Diesel
GENERAL ADVANTAGE					
Low cost per kW and per kWh	Abundant resource in Africa	Flexibility through diesel back-up	Easy storage (biomass, gas can be stored,	complementary source to solar PV or diesel	Independent of availability of RE resources
GENERAL LIMITATIONS					
Lack or seasonality of flow*	access to funds for high initial Investment	Access for diesel Supply	technology less mature than others	Spatial & temporal variability of the resource	Fuel Cost CO_2 & environmental impact

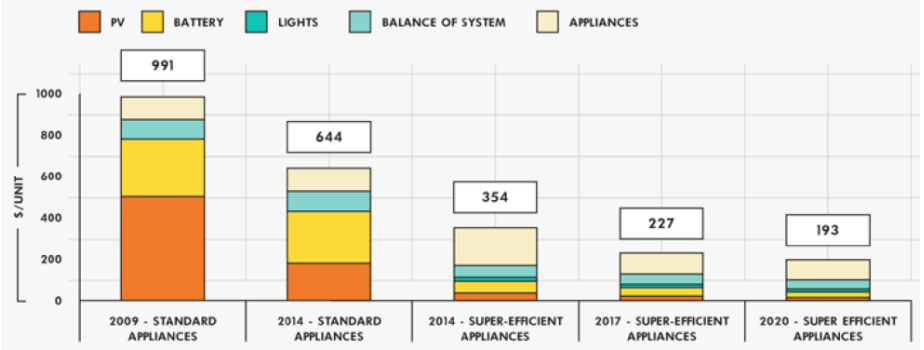
Sources : Lighting the World: the first application of an open source, spatial electrification tool (OnSSET) on Sub-Saharan Africa / Swiss Resource Centre and Consultancies for Development (Skat)

Solar Home System is the fastest & cheapest solution to meet the basic electricity needs in isolated areas

Portion of average household spending devoted to lighting



Cost trends of solar home systems with 19" TV, radio and two lights (US$/unit)

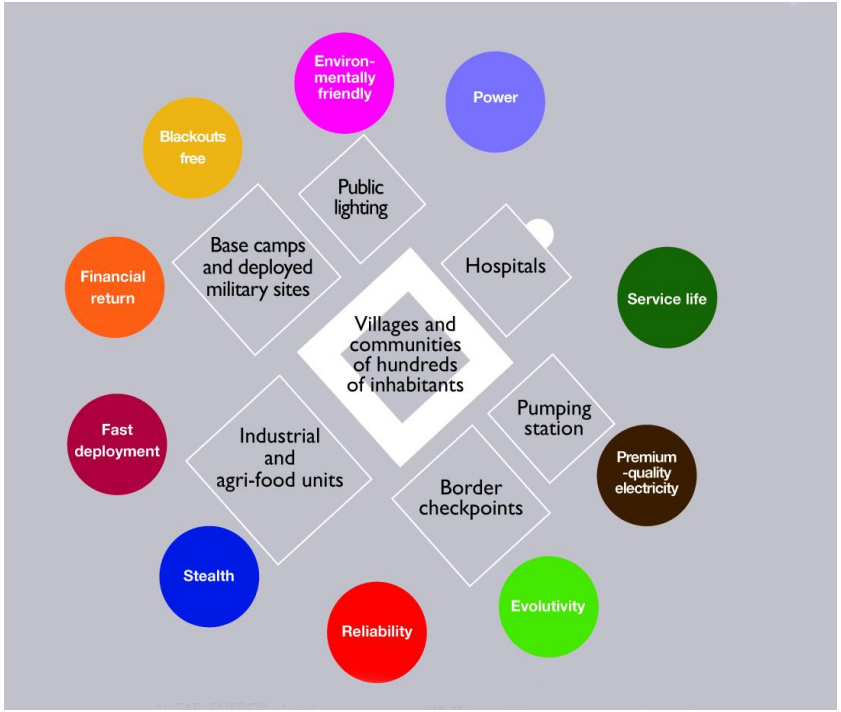


Beyond the drop in costs, the emergence of **pay-as-you-go models** transforms the market. They enable customers to pay the upfront costs of a solar home system in **affordable instalments** over time and **increases consumer confidence** by shifting the risk of faulty technology to the supplier. It allows houselholds to start climbing the **SOLAR ENERGY LADDER** (as their income rises, families and small businesses can afford larger systems)

Sources : Harrison, Scott and Hogarth (2016)

Energy services, with adapted energy solutions, in B2B markets will contribute strongly to meeting Africa's growing energy needs

Micro Grids solutions for large electrification



Between grid and mini-grid, large micro grid, LED public Lighting, District Cooling, telecom tower solarisation are some solutions to **provide electricity for industries and public sector**.

Sources : Engie, Ausar

The development of Energy Solutions in Africa can only result from the collaboration between all the relevant actors.

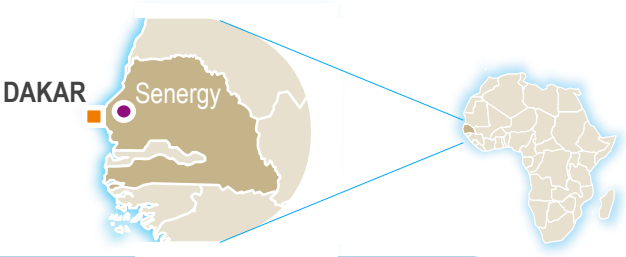
- **Centralized** : Governments, Utilities, Transmission & Distribution compagnies, IFC, banks, …
- **Decentralized** : Governments, Utilities, Telecom operators, local authorities, final clients, lenders, …
- **B2B Services** : Government, Utilities, International & National Industries, Local competences, Universities & Training institutions

In addition the implementation of **favorable governance** is necessary to stimulate and protect public and private investments

Sources : Engie

ENGIE Centralized Power generation

Senegal – Solar PV



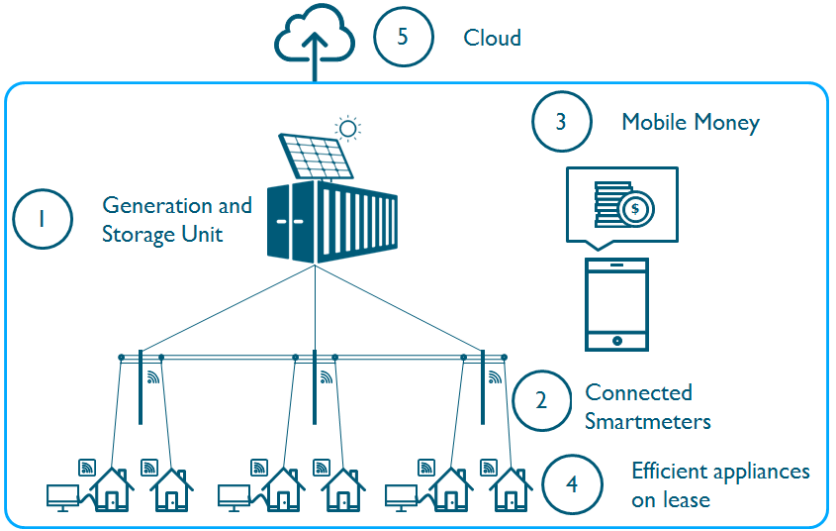
Senergy

- **30 MW** photovoltaic power plant in the City of Santhiou Mekhé
- Solairedirect standalone EPC and O&M contractor
- Transmission system including the double 30 kV line from the PV site to Mekhé Substation and its extension will be built and transferred to SENELEC
- 100% of the electricity output will be sold to SENELEC under a 25-year PPA

Kahone & Touba

- ENGIE and Meridiam were selected by Senegal's Electricity Sector Regulation Commission (CRSE) as preferred bidder in a tender launched in October 2017 for two solar photovoltaic projects totaling **60 MW**.
- Kahone will have a tariff of Euro cents **3.80/kWh**, while another plant located in Touba will have a tariff of Euro cents **3.98/kWh**.

Mini-Grids: ENGIE Africa Power Corner



Generation & storage
- Solar PV
- Battery Lithium
- Containerized solution

Distribution
- AC voltage
- Mono or triphase
- Smart meter

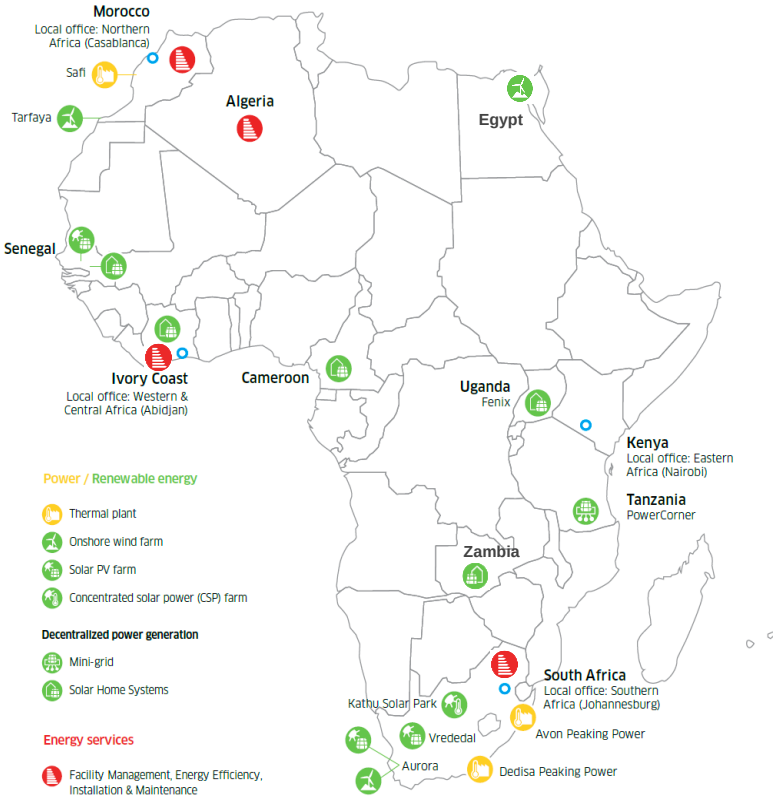
MUP
- Mobile money payment
- Activity monitoring
- Digital backbones

- **5 Power Corner in Tanzania**
- **Presence in 2 to 5 new countries next Year**
- **Ambition of thousands Power Corner to industrialize the solution**

Solar Home System : ENGIE Africa Fenix International

- **Fenix (350 FTE) has its main activities in Uganda where it is the leading SHS player with more than 140,000 customers**
- **Fenix recently expanded into Zambia and plans further roll-outs in other countries across Africa.**

ENGIE’s presence in Africa



Do you have QUESTIONS