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Off-grid solutions in the context of the booming African Telecom market

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Introduction: this poster focuses on electricity solutions powering remote telecom sites. We describe this market on several aspects: size (current size and forecasted), industry structure (value chain & actors), economical aspects (OPEX & CAPEX aspects) and technical configurations (zoom on off-grid hybrid diesel/solar sites) . This work is based upon research on 11 African countries and on feedbacks from major African Operators, Telecom Tower Companies and related actors.

Keywords and acronyms: base transceiver station (BTS), tower company (Tower co.), telecom operator (TelCo), diesel generator (DG), battery bank (BB), Operational Expenditure (OpEx), Capital Expenditure (CapEx), Energy Service Company (ESCO), Network Equipment Provider (NEP)

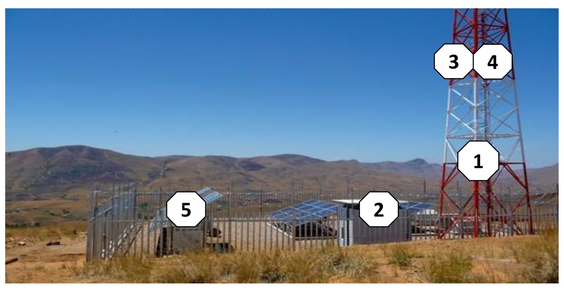
Countries studied**:** Northern Africa (Egypt, Algeria & Morocco), Sub-Saharan Africa (Ghana, Nigeria, DRC, Kenya, Tanzania, Uganda, Ethiopia & South Africa)

1 - POWER SUPPLY SOLUTION AT CELL SITES

1.1 Cell site definition

The **cell site** usually supports a mast/tower (1), the BTS (2), antennas (3), electronic communications equipment (i.e. transmitters/receivers) (4), primary and/or backup electrical power source (5) and a shelter. Usually, tower is misinterpreted as a BTS.

- **BTS:** it consists of a rack of a cabinet housing the elements for a "point to multi-point RF communication network": power amplifiers, combiners, duplexers, alarm system, control function and transceivers. BTS transceivers power defines the size of a cell site: each BTS has between one to tens transceivers depending on the density of users in the cell.



Source: Phaesun ©, Projet Telecom Mobile [1]

1.2 Example of power consumption (average)

- **Radio & transmission equipment:** less than 5kW (typ. few kW), 48V DC load
- **Active cooling:** 0,7 to 1kW or more, DC or AC load

1.3 Electrical power source:

- **"Bad-grid":** grid power is not available continuously. So DG runs hours (from 6 hours to 12 hours per day) & fuel consumption can be very high.
- **"Off-grid":** powered by 1 or 2 primary DG or hybrid solution.

2 - OFF-GRID TELECOM SITES IN AFRICA

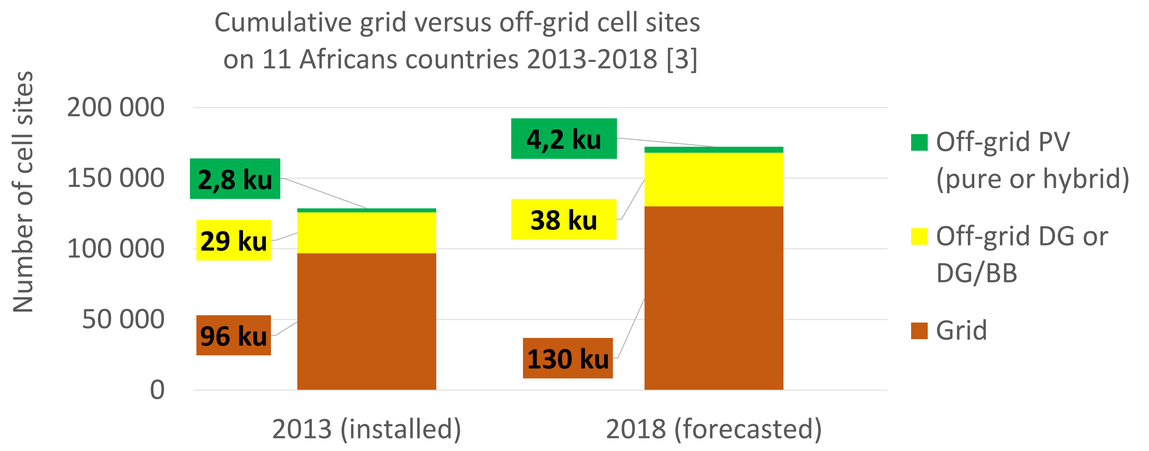
2.1 Overview of African telecom network size

In Africa, TelCo have deployed a significant part of their telecom infrastructure in off-grid or bad-grid areas. The 11 countries studied represent a quarter of off-grid sites in Africa and almost 56% of off-grid solar installed sites [2].

2.2 Zoom on 11 countries: installed capacity and forecast

Those 11 countries can be divided in 2 categories:

- Northern Africa: Egypt, Algeria & Morocco → **Mature market**.
  - *Mobile market:* penetration levels are higher than 105% & annual subscriber growth rates are below 5% [4].
  - *Network*: with an average national electrification rate higher than 95% and well developed national grids, only a few % of sites are off-grid [5].
  - *PV*: installation of PV sites has started at the beginning of 90's, representing 1/4 of off-grid installed sites [3].
- Sub-Saharan: Ghana, Nigeria, DRC, Kenya, Tanzania, Uganda, Ethiopia & South Africa → **Growing market**
  - *Mobile market*: penetration levels are below 75% & annual subscriber growth rates are up to 25% [4].
  - *Network:* with an average national electrification rate of 36% and 63% of population living in rural areas, off-grid sites represent a significant part of the network infrastructure [5].
  - *PV*: installation of PV sites began in 2000's and represent only a few % of off-grid installed sites [3]. Nevertheless, this market has a huge potential for future development with hundreds of on-going projects identified [3].



3 - TELECOM INFRASTRUCTURE INDUSTRY AND EXAMPLE OF ACTORS - 11 SELECTED COUNTRIES

The telecom infrastructure industry in these 11 countries is represented by TelCo and Tower co. Power equipments are mostly owned by TelCo, but transfer of tower assets to Tower co. has grown over the past few years. The emergence of this tower co. model has slow down the adoption of solar energy due to delay in investment and impact of tower sales. Nevertheless, there is a surge in African tower deals and African Tower Co. now own and operate 20% [3] of the towers of these 11 countries and are looking at longer term energy investments to achieve sustainability and cost efficiency. Besides TelCo., Tower co. telecom equipment suppliers offering telecom and power/electronic solutions ("components", "NEP," "system integrators"), and national service companies (engineering, operation and maintenance) will be crucial drivers for the development of solar sites.

COMPONENTS	NETWORK EQUIPMENT PROVIDER (NEP)	INTEGRATION, INSTALLATION, O&M	TOWER CO.	TELCO OWNERSHIP (CDMA & GSMA)
Generators: ❑ Cummins (US) ❑ FG Wilson (UK) ❑ Caterpillar (US) ❑ Ascot International (IT) **Power electronics:** ❑ Eltek (NO) ❑ Emerson Network Power (US) ❑ PowerOasis (GB) **Storage:** ❑ Northstar (SE) ❑ Gildemeister (GE) ❑ GE Energy Storage (US) **Solar panels**: international actors	**European:** ❑ Ericsson (SE) ❑ Alcatel-Lucent (FR) ❑ Nokia Networks (NL) **Asian:** ❑ ZTE (CN) ❑ Huawei (CN) ❑ VNL (IN)	**System integrators:** ❑ Flexenclosure (SE) ❑ Hybrid Energy (IE) ❑ Heliocentris (DE) ❑ Orun Energy (MU) ❑ Clean Power Systems (AE) **Engineering:** local companies **Installation:** local companies **Maintenance:** local companies	**International:** ❑ American Towers (US) ❑ IHS (GB) ❑ Helios Towers Africa (GB) **Regional & National:** ❑ SWAP (NG) ❑ Helios Towers Nigeria (NG) ❑ Eaton Towers (GB)	**International:** ❑ Orange (FR) ❑ Vodafone (GB) ❑ Etisalat (AE) ❑ Essar (IN) ❑ Bharti Airtel (IN) **African:** ❑ MTN Group (ZA) ❑ Globacom (NG) ❑ Milicom Group (LU)

4 - ECONOMICAL ASPECTS - CAPEX VS. OPEX

4.1 CapEx

Usually, investment comes from the TelCo or Tower co. CapEx is driven by cost of DG, batteries, solar panels and other power electronics equipment. 3 solutions are implemented to reduce CapEx:

- sharing of passive infrastructure (via TelCo.)
- minimizing the energy spent on cooling (free cooling).
- using a 3rd part energy service company (ESCO) to invest the CAPEX. In this case, the TelCo pays an energy access fee.

4.2 OpEx

It's mainly driven by the cost of maintaining the tower sites, diesel availability (transportation, storage, pilferage) and prices. Energy cost could represent 50% of OpEx at an off-grid site. 3 solutions are mostly used to reduce OpEx:

- improving cooling efficiencies
- reducing energy consumption by using low power consumption electronics
- using hybrid solutions including renewable energy

5 - OFF-GRID POWER GENERATION - TECHNICAL CONFIGURATION

An off-grid hybrid solution combines a single DG and PV panels, with dedicated cycling battery bank. A typical 2G outdoor site, for a single operator, consumes 2 to 3 kW of energy. Typical power configuration is described below:

DG

- **Power:** 6 to 20 kVA, AC/DC
- **Run-time**: 4 to 18 hours per day
- **Fuel tank capacity:** 500 to 2 500 l.
- **Fuel consumption:** 3 to 6 l./hour
- **Telemetry systems**

Battery bank

- **Power**: 800 to 2 000Ah
- **Voltage**: 48V
- **Autonomy**: few hours, up to 12 hours
- **Technology**: lead acid batteries VRLA (GEL/AGM)

PV equipment

- **PV capacity**: 1 to 10kW
- **Charge controllers / inverters**
- **Monitoring system**

References: [2] Infinergia ©, "Africa PV off-grid market analysis on 33 countries", 2015. [3] Infinergia ©, "GSM Telecom Infrastructure in Africa", 2015. [4] World Bank, "Mobile cellular subscriptions (per 100 people)", 2010-2014. [5] Infinergia ©, "Off-grid PV macro-economical modeling on country dynamics", 2014.