# Open DC Grid Project

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# Agenda

- USB-PD 3.1 Review
- Microgrid Finance
- Related Standards / Industry Developments

# USB-PD 3.1

* Chris Moller presentation
* USB-PD 3.1 Download

# Microgrid Finance
# Sources of Capital for Mini-grid Projects

**Types of Financing**

| | |
|---|---|
| **Grants** | Money awarded that does not need to be repaid. Grantmakers usually provide funds to achieve specific social, environmental and other development objectives. Common sources of grants are government agencies, international donors, private foundations and non-profit development organizations. |
| **Equity** | Funds given in return for partial ownership of the company. Sources of equity include impact investors, angel investors, venture capital, investment firms and multilateral or bilateral clean energy funds. |
| **Debt** | Money borrowed by an organization to be repaid over time with interest. Commercial banks are the most common source of debt, including both loans and lines of credit. Other sources include international donors and private foundations. **The World Bank** and other development institutions use clean energy funds to provide commercial banks with lines of credit for loans to mini-grid projects. |
| **Mezzanine Finance** | Funds provided as a loan that the lender can convert to equity if the borrower does not repay. Mezzanine finance is a hybrid of debt and equity financing. |

Source: USAID

# Microgrid Finance Overview

**What are the sources of capital for mini-grid projects?**

Various investors can be sought out to provide capital according to the three key project stages: prefeasibility and feasibility studies, construction and commissioning and operations. **Read more »**

**What financial instruments are available to cover the costs of building a mini-grid?**

Grants, debt, equity and mezzanine finance are common, while project-based financing, first-loss loans, renewable energy funds and in-kind or cash-equity contributions from beneficiaries have also been used. **Read more »**

**What sources of grants or concessional financing exist to help with mini-grids in developing countries?**

International funding agencies, private foundations, non-governmental organizations and developing-country government programs can be sources of free or cheap capital in the form of grants or concessional loans. **Read more »**

**If mini-grids are integrated with the centralized grid, who will finance the necessary upgrades to the main grid?**

Utilities, project developers, rural electrification agencies or donors may pay for the upgrades based on a variety of considerations. **Read more »**

Source: USAID

# Microgrid Finance
## Technical Info from USAID

### Standardized DC Receptacles and Appliance Plugs

Outlets—the receptacles where appliances plug in to receive electricity—are the last point in the distribution systems. Unfortunately, the outlets designed for DC use are poor fits for appliances. The *de facto* low-voltage DC standard for receptacles and plugs is based on cigarette lighter ports in cars. These ports are bulky, and they have low power ratings. Often, poor contact reliability interrupts the flow of power from the outlet to the appliance.

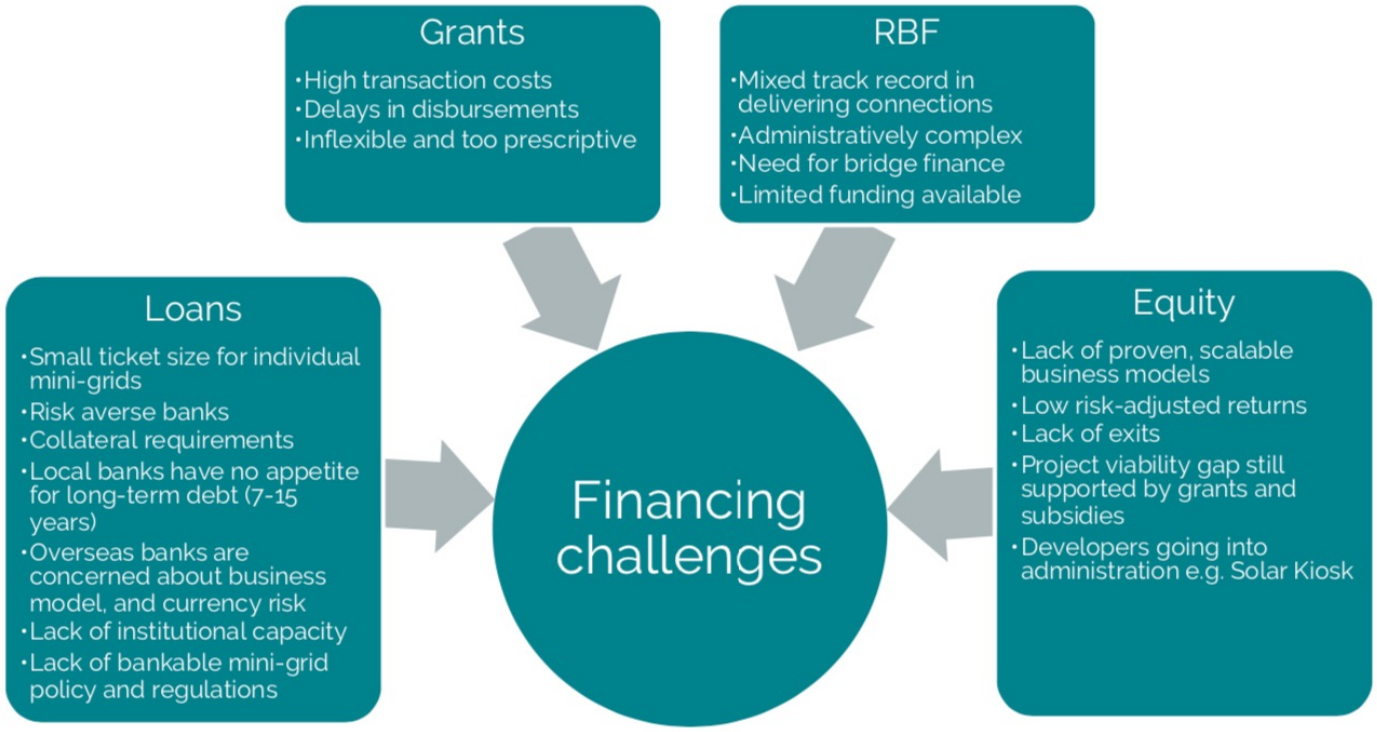
Improved DC receptacles would increase the use of low-voltage DC mini-grids and solar home systems. Adopting a new standard is a more promising approach than incrementally improving the current standard based on automobile lighters. One emerging standard is **Anderson Powerpole connectors**, available as inline connectors and wall-mounted sockets. These connectors provide higher current and more reliable connections. Anderson Powerpole connectors are widely used in industrial applications and amateur radio.

**Anderson Powerpole connectors**

# Microgrid Finance
## Role of Standards in Finance

* Business self-finance
  * Mesh Power Rwanda
* Third-party project finance
  * Impact investors, minigrid debt funds, crowd-funding
  * World bank projects
  * IEEE Smart Village
* Government finance
  * Public-private partnerships - Africa
  * India
* Local investment
  * Franchise model?

# Microgrid Finance
# Issues with Funding Sources




Source: AFDB Green Help Mini Desk

# Microgrid Finance Financial Products

| | Grants and subsidies | Equity | Debt |
|---|---|---|---|
| **Types** | Most mini-grids rely on grants and subsidies for at least 30% of the investment costs. Grants and subsidies can be used for:<br>• Grants for feasibility studies<br>• Construction grants for capex – focus on distribution assets<br>• Results-Based Financing e.g. for new connections<br>• Promotion of productive users - technical assistance / purchases of electrical equipment | Most developers require capital from equity investors. Equity can be used for:<br>• Seed capital<br>• Expansion capital<br>• Investments in operating assets | So far very few mini-grids have secured loans. Loans can be used for:<br>• Concessional or commercial loans<br>• Green credit lines to local banks<br>• Loan refinancing facilities<br>• Loans to governments for mini-grid equipment, perhaps backed by export credit guarantees<br>• Loans to end users for electrical equipment, perhaps backed by loan guarantees |
| **Providers** | DFIs, host governments, trusts and foundations, philanthropists, crowd funding | Angel investors, VC, impact investors, trusts and foundations, strategic investors, private equity, family offices, crowd funding, DFIs | DFIs, banks, foundations, family offices, crowd funding |
| **Route to market** | Public tenders, reverse auctions | Direct or indirect via funds | Direct or indirect via funds |

Source: AFDB Green Help Mini Desk

# Microgrid Finance
## Financial Products by Project Size

| | Type 1 | Type 2 | Type 3 |
|---|---|---|---|
| **Size** | 1-10 MW | 100 kW – 1 MW | < 100 kW |
| **Main customers** | Anchor load, e.g. semi-industrial, supplying excess to state utility | Small businesses or anchor load | Households or small businesses |
| **PPA** | Yes | Yes/No | No |
| **Payment** | Post pay | Post pay or pre-pay | Pre-pay |
| **Financial product** | Commercial equity and debt, grants for connections<br><br>Corporate or asset finance or project finance | Grants and equity required. Debt starting to be used<br><br>Corporate or asset finance. Project finance possible if mini-grids are clustered. | Grants and equity required. Debt starting to be used.<br><br>Corporate or asset finance. Project finance possible if mini-grids are clustered. |

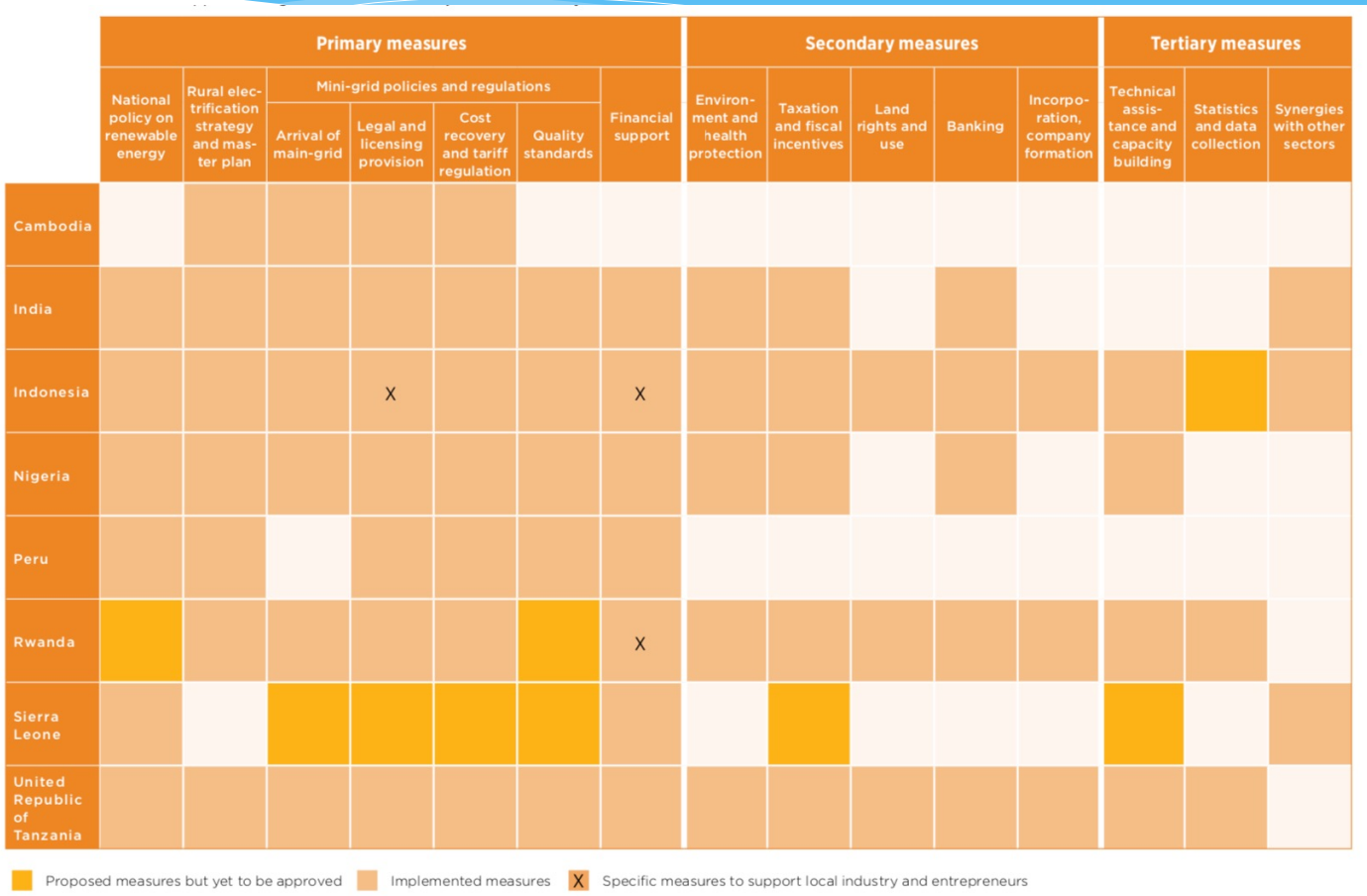
Source: AFDB Green Help Mini Desk

# Microgrid Finance
## National Regulations and Standards

* Regulations
  * Most countries have mini-grid licensing requirements
* National Standards
  * Quality assurance frameworks

# Microgrid Finance

## Examples of National Policies




Source: IRENA

# Microgrid Finance
# DC- Quality Assurance Framework

**Table 13. Percent Voltage Drop for a Level of Service**

| Level of Service | Quality |
|---|---|
| Base | Within 30% of sending-end voltage |
| Standard | Within 20% |
| High | Within 10% |

**Table 14. Ripple for Given Level of Service**

| Level of Service | Quality |
|---|---|
| Base | 10% of pk-pk |
| Standard | 5% of pk-pk |
| High | 2% of pk-pk |

**Table 15. Switching Noise for a Given Level of Service**

| Level of Service | Quality |
|---|---|
| Base | Unfiltered |
| Standard | Transient noise minimized |
| High | Ripple noise minimized |

**Table 16. Transient Protection for a Given Level of Service**

| Level of Service | Quality |
|---|---|
| Base | No additional protection |
| Standard | Surge suppressors |
| High | Surge suppressors |

**Table 17. Number of Faults Allowed Per Day for a Given Level of Service**

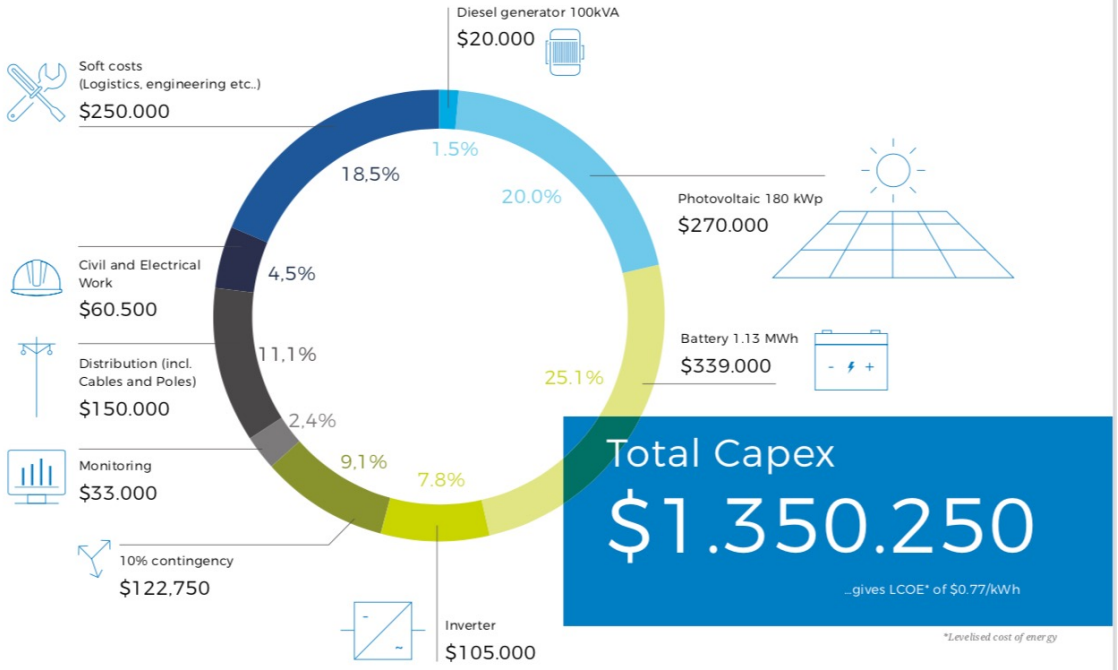
| Level of Service | Quality |
|---|---|
| Base | <5 per day |
| Standard | <2 per day |
| High | <1 per day |

[Source: NREL Quality Assurance Framework for Mini-grids]

# Microgrid Finance
# Example Mini-Grid in Kenya



The example below describes typical, if simplified, financials for a hybrid solar diesel microgrid in Kenya.




Source: TFE Energy

# Microgrid Finance
# Example Mini-Grid in Kenya



## Running the numbers: A microgrid business case

Expected demand growth:
5% p.a.

Electricity distributed as AC (single- and 3-phase) via overhead wires and poles. Meters are also often mounted on poles.

250 Customers

Distribution Loss: 10%

6km total

Diesel generator
Capacity: 100 kVA
Energy: 15 MWh/year

Lead acid battery
Capacity: 1.18 MWh
Depth of Discharge: 60%

Photovoltaic system
Capacity: 180 kWp
Energy: 320 MWh/year

Power is generated by a solar PV array and supplemented by a diesel generator. Excess electricity is stored in a battery bank. In some cases the system is integrated with the National Grid

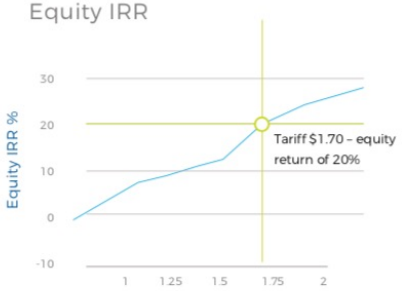
Commercial
Connection Fee: $10
Commercial Tariff: $1.00/kWh
Commercial power use: 65%

SHOP

Residential
Connection Fee: $10
Residential Tariff: $2.50/kWh
Residential power use: 35%

Productive uses such as a shop or maize mill provide better revenues. Resendential users provide necessary diversification of customer type and add to socioeconomic impact

### The Effect of Tariffs on Equity IRR




*Source: Allotrope Partners "Microgrid Market Analysis*

### Business Plan

| | |
|---|---|
| Project/ Equity IRR: | 12%/ 16% p.a. |
| Equity/ Debt: | 40%/ 60% |
| Interest rate: | 10% (12 years) |

Source: TFE Energy

# Microgrid Finance
## Rural Electricity in India

* Saubhagya Scheme – subsidized power for poor/rural
  * Claims 99.99% of Indian household electrified by 2019
  * Other sources suggestion much lower
  * 2020 82% of customers have never paid a bill
* Power quality issues
  * 76% rural households experience 1 outage/day
  * Specific issues
    * Long blackouts
    * Low voltages
    * Appliance damage from voltage fluctuation
* Remaining issues
  * 81% of rural household depend on biomass for cooking
  * 20% depend on non-electrical sources for lighting
  * 55% of sown area non-irrigated due to unreliable power
* TATA Power and CSC plan 10K minigrids – 100 constructed so far

# Microgrid Finance
## Private Energy Projects in India

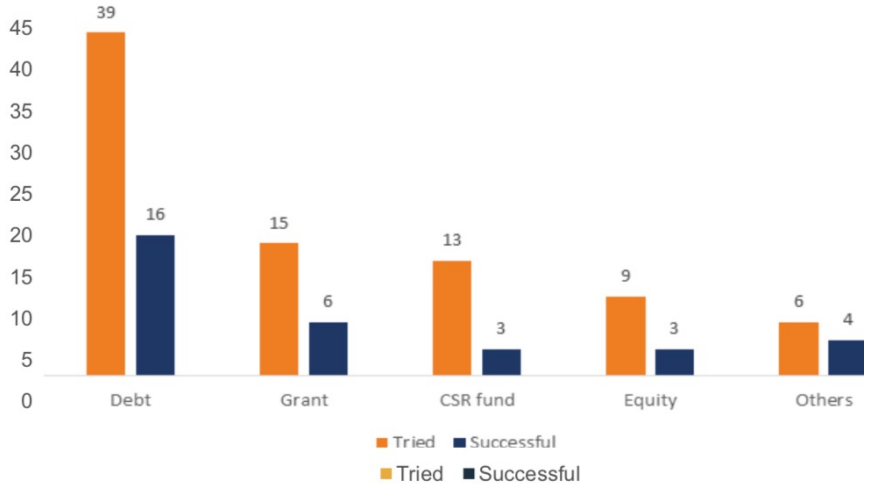



**Figure 18. Financing sources for FY 2019/20**
(Sample size: 32 enterprises)

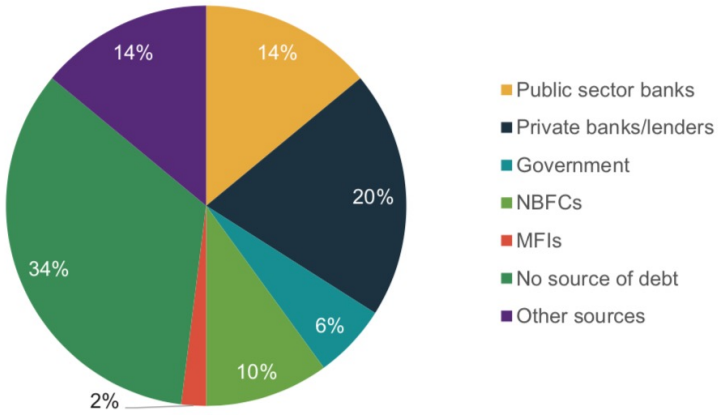



**Figure 19. Ongoing source of debt**
(Sample size: 37 enterprises)

Source: SHAKTI Sustainable Energy Foundation

# Related Standards / Industry Developments

* P2030.10
  * Awaiting IEEE approval – only 1 objection to 2nd recirc
* LFEnergy
  * Microgrid SIG architecture focus on Hyphae
* Zephyr Developer Summit – June 8 – June 10
  * Mini-conference on Zephyr-driven power electronics planned
* OwnTech – Open Digital Power?
* P2030.10.1
  * Getting ready for ballot – no recent activity
* GOGLA Interop activities - ?
* OpenPAYGO Link - ?
* Angaza Nexus Channel / Nexus Channel Core - ?
* Open Connectivity Foundation / IoTivity - ?

# Next Meeting / Feedback

* Next Meeting
  * 13 July 2021 – 1400 UTC
  * Zoom – Meeting ID 87518284403 password: opendcgrid
* Sharing Portals
  * Web site: https://open-dc-grid.org/
  * GitHub: https://github.com/open-dc-grid