INTEGRATED MINI-GRIDS

An approach that yields the best sides of the on- and off-grid approach

An approach inspired by INTEGRATION's experience in Bangladesh

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INTEGRATION
environment & energy

The overall financial challenge for mini-grids

PV-Battery Mini-grids and PV-Diesel-Battery Mini-grids are often hardly financially viable due to…

Generic challenges

- High tariffs
- Low consumption

Regional challenges

In Nigeria and some other countries…

- Grid expansion in peri-urban and rural areas limits the number of attractive off-grid sites substantially
- This is often combined with poor electricity services within distribution networks due to outdated transmission infrastructure and/or lacking generation

A new solution - Interconnected mini-grids

2016 NERC Mini-Grid Regulation: Interconnected Mini-Grids (IMG)

- In 2016 NERC introduced the Mini-Grid Regulation, which includes the concept of Interconnected Mini-Grids (IMG)
- In agreement with the DISCO, a private operator can request a license to operate an on-grid area of the distribution network by adding local generation and serving the end-users

The concept makes perfect sense, but the incentives and risks are unbalanced or uncertain

Some pieces of the puzzle are missing

It presents risks for Stakeholders

Operator / Investor

An improvement of supply within the utility grid can lead to stranded assets and jeopardize the business model (lack of certainty)

DISCO

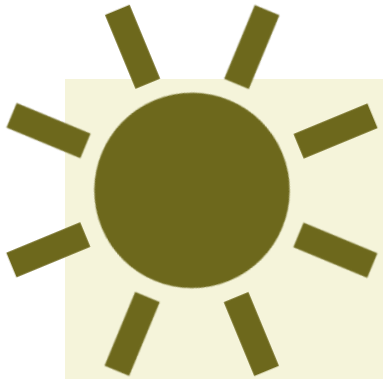
***Loses the opportunity** to serve the community on its own or sell more power with increased availability (dispatch by Gen-Cos)*

Communities

*Some users may accept "**mini-grid like tariffs**" but some won't (or change their opinion when the overall supply in the area improves) - high conflict potential*

Adding the missing pieces - **Integrated** mini-grids

INTEGRATION environment & energy proposes: (1) Day and night supply and tariff differ



Daytime service and tariff

- PV system designed to cover day-time load (fewer batteries)
- Right of way for PV power (initially no integration of grid power)
- Optimization between tariff and service level (e.g. acceptance of few downtimes)
- Grid is formed by either diesel generator or an off-grid battery inverter

Night-time service and tariff

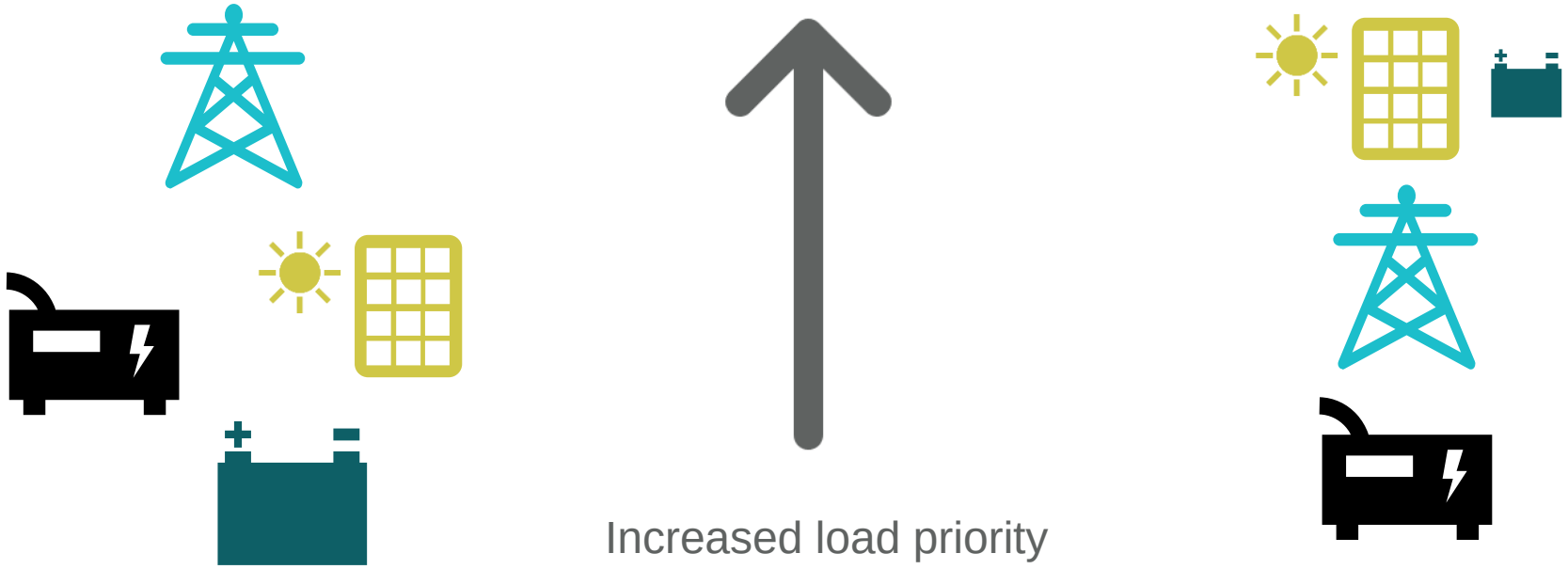
- A guaranteed supply duration is agreed from the diesel generator (e.g. 4 hours)
- Initial tariff is decided based on the current availability of the energy mix
- In case grid power becomes available, the tariff is reviewed every second year (with an option to lower it if utility grid supply has increased)

Adding the missing pieces - **Integrated** mini-grids

INTEGRATION environment & energy proposes: (2) PV-system sizing for daytime loads

Interconnected mini-grids

Integrated mini-grids



Increased load priority

Integrated mini-grids put the priority of generation source first on the renewable supply

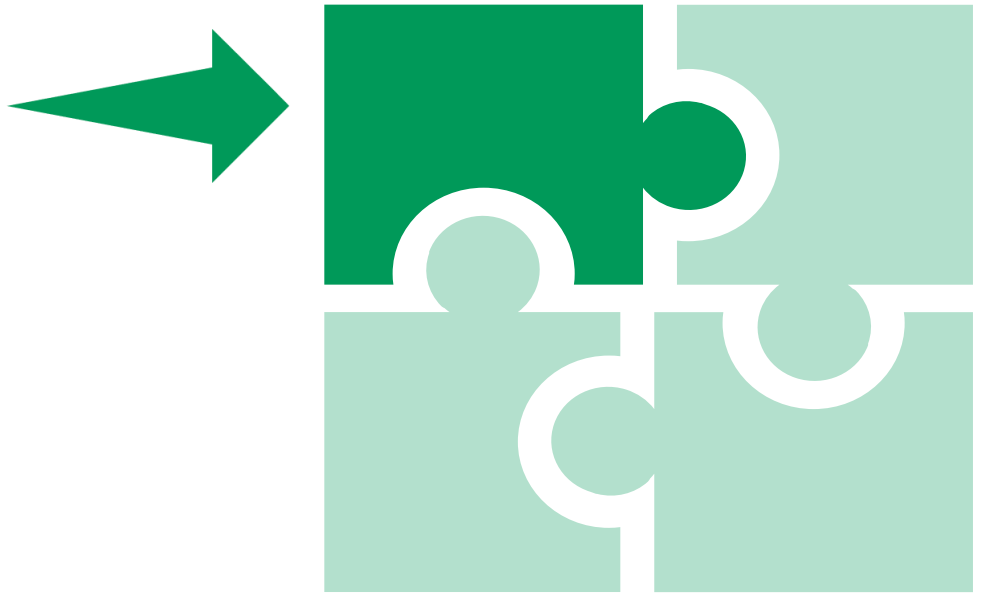
Adding the missing pieces - **Integrated** mini-grids

To find the puzzle pieces, INTEGRATION environment & energy proposes the “integrated mini-grid concept”

In this concept, the energy supply and tariff during the day is different from the energy supply and tariff during the night.

- During the day PV generation is the priority and no power from the main grid is fed-in.
- During the night, a diesel generator supplies power and is potentially supplemented by the utility grid

In the event of a more reliable supply from the utility grid, the PV remains connected and supplies over the daytime, but the diesel generator use can be reduced and eventually removed



The 3 pillars of the **integrated mini-grid**

Pillars of the **Integrated mini-grid** concept

Differences in day and night supply

- In the daytime, **PV generation has priority** (no utility dispatch)
- A diesel generator covers peak evening demand, if available supplemented by the utility grid
- Daytime and night-time **supply quality** is agreed with stakeholders
- **Two tariffs** – day and night

Improved utility grid supply benefits everyone

- The mini-grid operator is more ascertained to sell PV generated
- Grid power may be dispatched during the night-time only
- In this event,
  - the **community** may see a reduction in night-time tariff
  - there will be **few stranded assets** as the solar PV will continue to supply

Future-proof business models for stakeholders

- The **service level** for customers will be high immediately
- Tariffs are above then in the main grid, but
  - the **optimized layout** supports affordability
  - lower daytime tariffs **incentivises use of PV**
  - Night-time tariffs can be lowered over time

- Overall, the system **design is robust** and ready for **larger capacities**

Integrated mini-grids have positive effects

The operator:

- The PV system is always used
- Does not have to invest in a large battery bank or PV system designed for peak evening supply
- Is able to control the operational costs of the diesel generator based on the agreed service level

The community:

- Are incentivised to use power during the day-time due to lower tariff level
- Benefits from increased power availability and quality immediately
- Still has the chance for tariffs to be lowered during the night-time when utility grid supply improves

The DISCO:

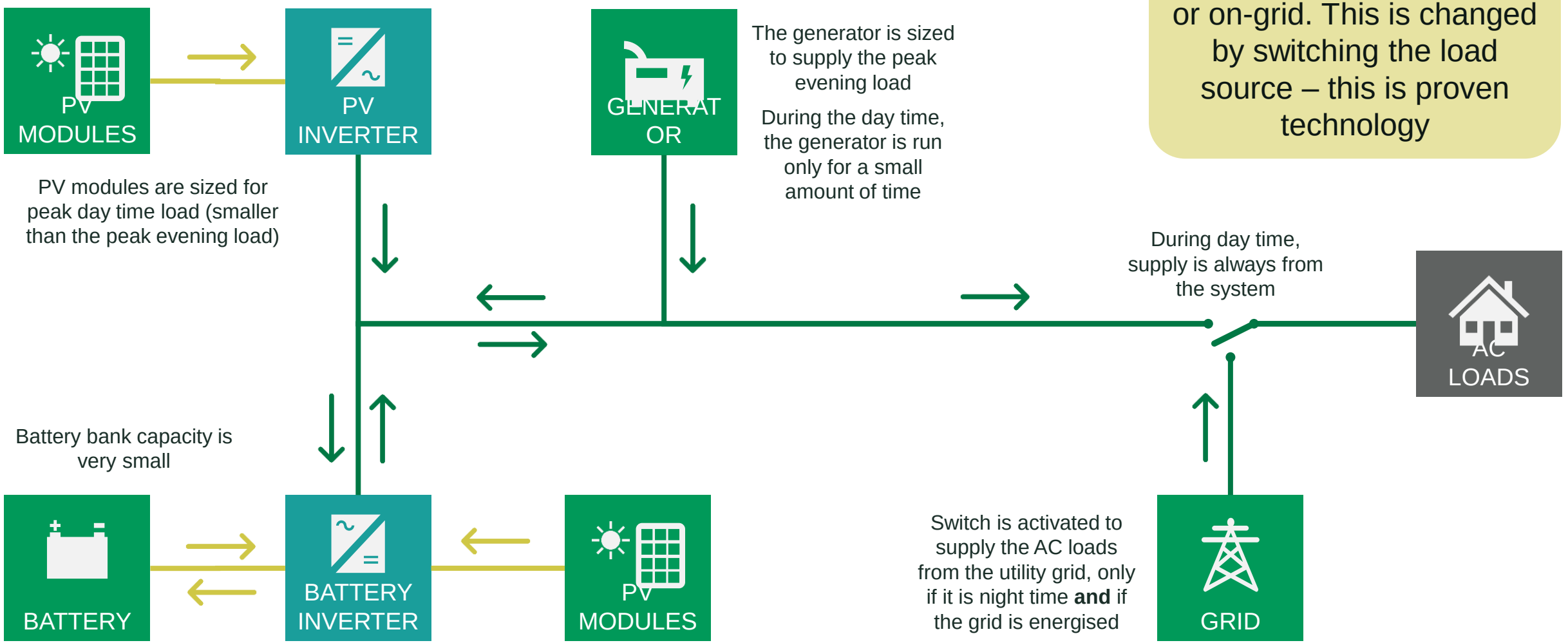
- Sells power at a profitable rate to the operator (during night-time) with very little handling cost
- May takes over a metered and well maintained system at the end of the license term

The environment:

- Diesel genset is phased out over time with increased utility grid input
- PV generation stays on the grid indefinitely and contributes to the renewable energy share for Nigeria

The technical solution

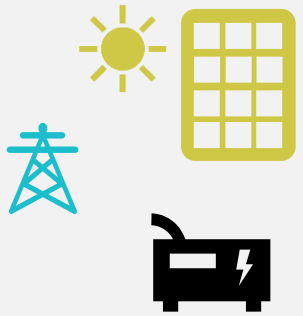
System is **either** off-grid or on-grid. This is changed by switching the load source – this is proven technology



Potential problem with the technical solution

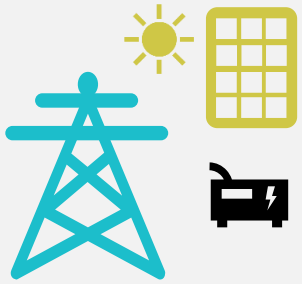
Current situation

The technical solution can work well with areas where the utility grid supply is currently weak



Future situation

But what happens when the grid supply becomes stronger? How can we integrate the PV and grid during the **daytime**?



An investigation will be made into different technical options to help solve this issue

Next steps

Receive **feedback** on the proposed model, particularly on:

- Power dispatch from the main grid during night only
- Agreeable rates for the grid power supply

Develop **technical requirements** for system components

Develop **financial modelling** and tariff calculation

Adjustment of the **tender documents**

THANKS FOR LISTENING!

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