CLEAN CAPTIVE INSTALLATIONS FOR INDUSTRIAL CLIENTS IN SUB-SAHARA AFRICA

Clean Captive Installations in sub-Sahara Africa

Webinar | Session 2

Summary of the Ghana country study and Tools

FS-UNEP Collaborating Centre

24th March, 2021 | Total duration - 70 minutes

Supported by:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
based on a decision of the German Bundestag

Frankfurt School FS-UNEP Collaborating Centre for Climate & Sustainable Energy Finance

UN environment United Nations Environment Programme

Webinar | Agenda

Session 2

START	TOPIC	PRESENTER
5 minutes	**WELCOME** Introduction to Webinar Session 2	**DIANA KOLLANYI** (FS-UNEP Collaborating Centre) 
15 minutes	**GHANA COUNTRY STUDY REPORT** Overview of Ghana Energy sector and its potential for Clean Captive Power Installations	**CAROLINA MERIGHI** (UNEP) 
50 minutes *10 minutes*	**INTRODUCTION TO THE CCI TOOLS** **Tool 4** | Best Available Technology (BAT) for solar PV captive systems	**SARAH MOUSTAFA** (FS-UNEP Collaborating Centre) 
15 minutes	**Tool 2** | Metrics for assessing financial viability of renewable energy Projects/Cost Benefit Analysis of renewable energy programmes	**MARIA BAEZ** (FS-UNEP Collaborating Centre) 
25 minutes	**Tool 1** | Financing guidelines and business models for solar PV Captive Systems **Tool 3** | User Manual for the preliminary financial model to assess the viability of solar PV captive systems for businesses	**MADHUMITHA MADHAVAN** (FS-UNEP Collaborating Centre) 

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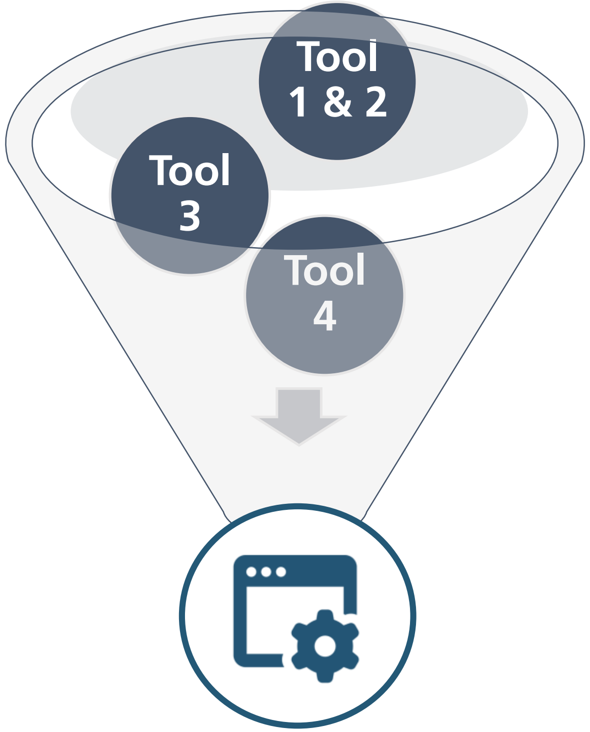
Webinar | Introduction

Session 2

Session 1:
Launch of call for proposals for pilot projects (learnt about Type I, II, III projects)

Session 2:
Overview of the Ghana Energy sector

… and its potential for Clean Captive Power Installations



Session 2:
Set of tools as introductory guidelines to support in:

- Understanding various available financing options for clean captive solar PV projects, and
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Country study | Ghana

Introduction

The Ghana Country report presents the state of the clean captive installations market in Ghana, with a focus on the commercial and industrial market and solar photovoltaic (PV) technology.

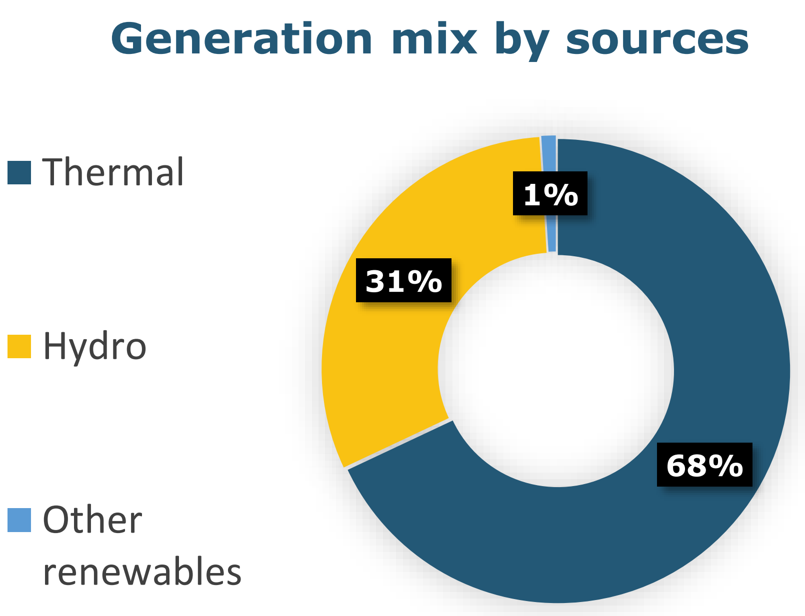
Download from website:
captiverenewables-africa.org/publications/

Country study | Ghana

Energy profile

Ghana generates electricity mostly from thermal sources and hydro sources.

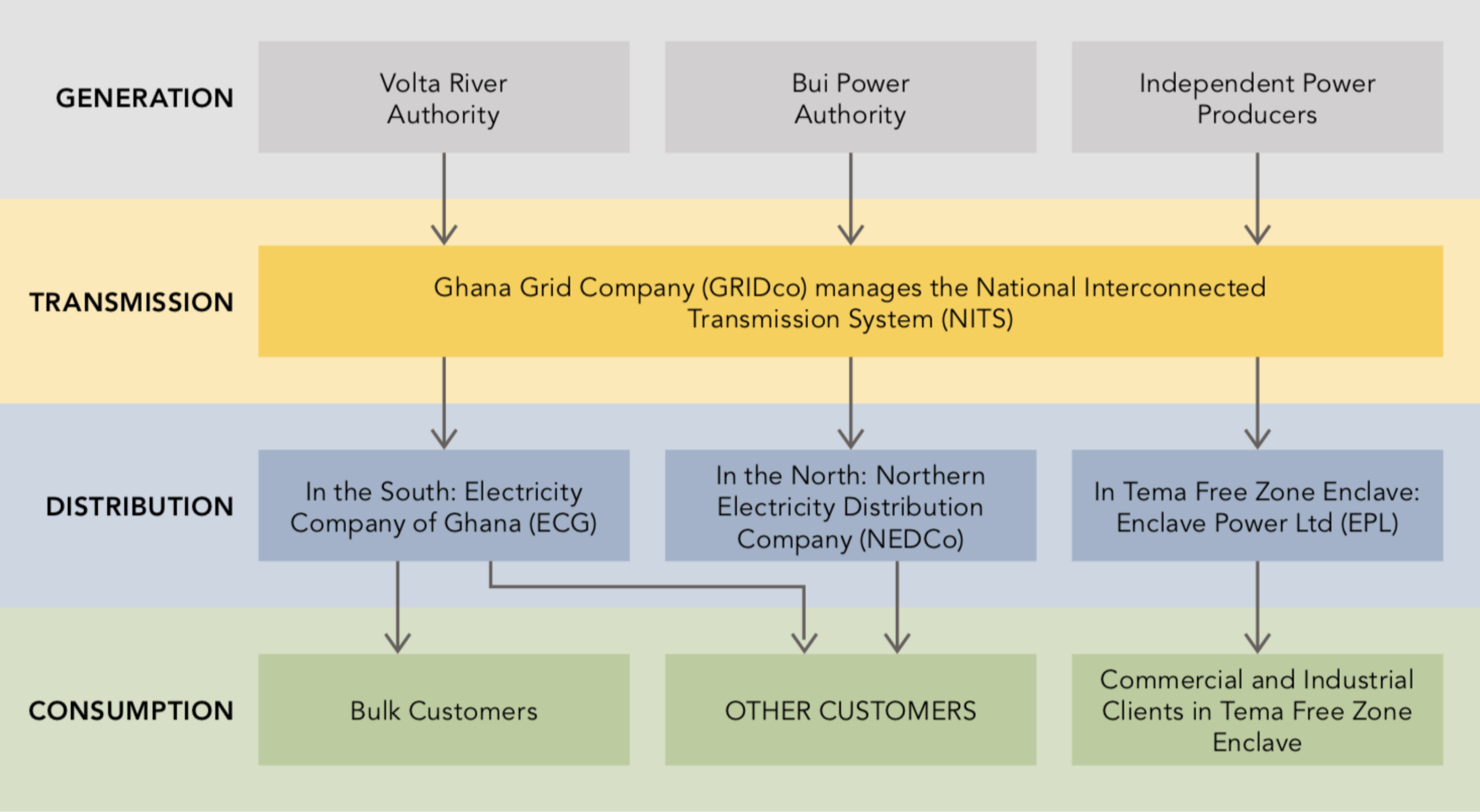
Energy indicator	Result
Access to electricity	82.40%
Electrification – urban areas	94.19%
Electrification – rural areas	67.35%
Average cost of generation	US$ 0.154 per kWh
Total electricity generation	16 213.4 GWh
Total electricity consumption	14 330 GWh
Sectoral electricity consumption	10 973 GWh
Electricity total installed capacity	5 048 MW
Peak electricity demand	2 525 MW



Country study | Ghana

Electricity market structure

The public sector plays a dominant role in the electricity market in Ghana. In 2005, the government of Ghana unbundled the electricity sector as part of the power sector reforms.



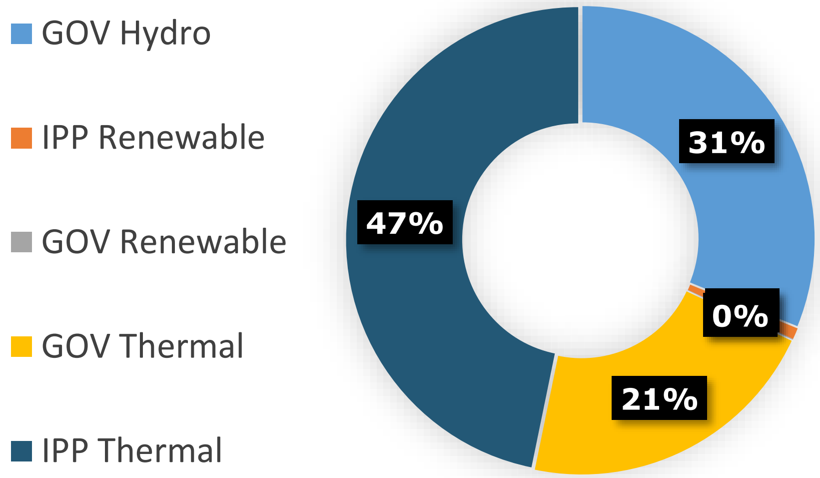
Country study | Ghana

Electricity generation

Ghana's generation mix has been undergoing a transformation over the years. The current electricity generation in Ghana relies increasingly on fossil fuels.

Energy indicator	Result
Total installed generation capacity	5 048 MW
Generation by GOV-owned companies	52.4%
Generation by IPP from private sector	47.6%
Electricity from thermal sources	68%
Electricity from renewable energy sources	0.84%
Electricity from hydro	31.15%

Generation mix by sectors

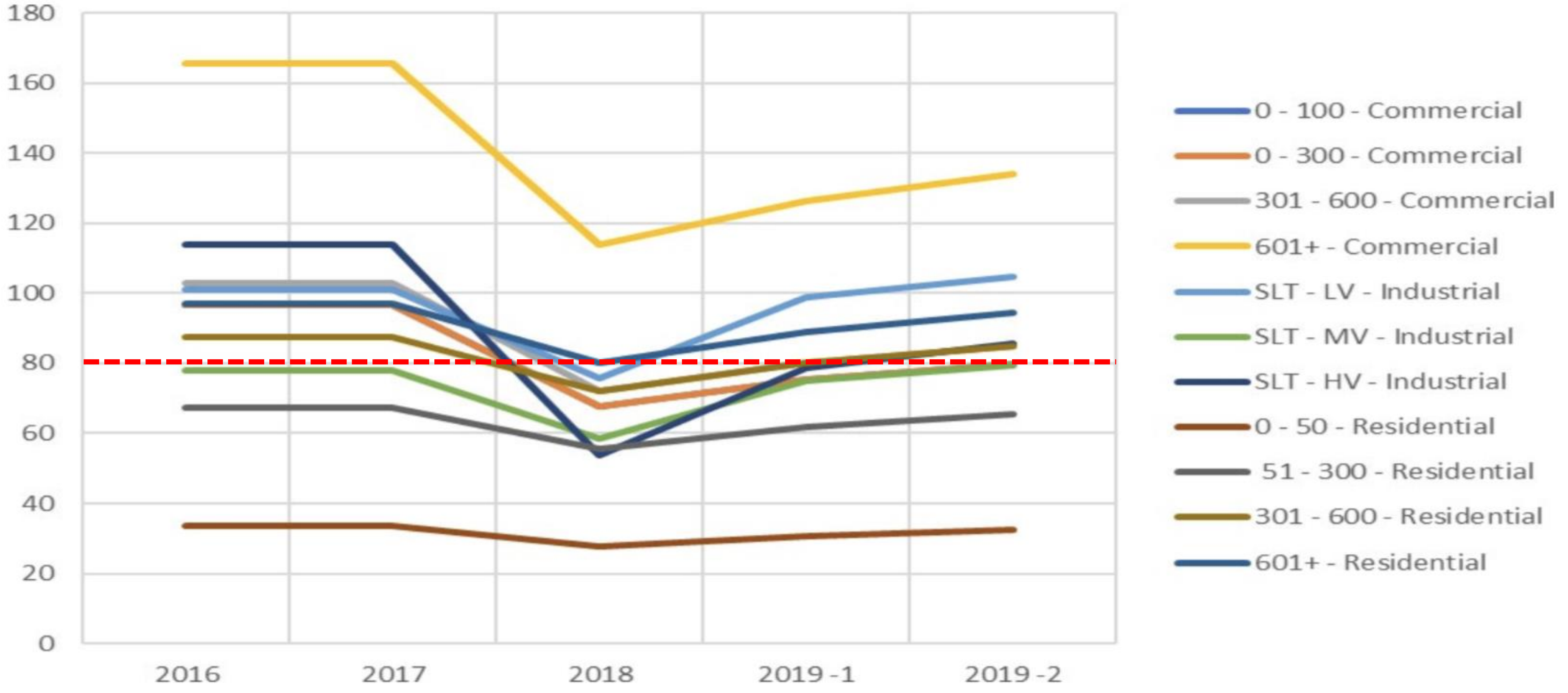


Despite the total installed generating capacity being higher than peak demand, Ghana experiences shortages of electricity supply.

Country study | Ghana

Electricity sales

Tariffs across the different customer categories from 2015 to 2019 in Ghanaian pence



Country study | Ghana

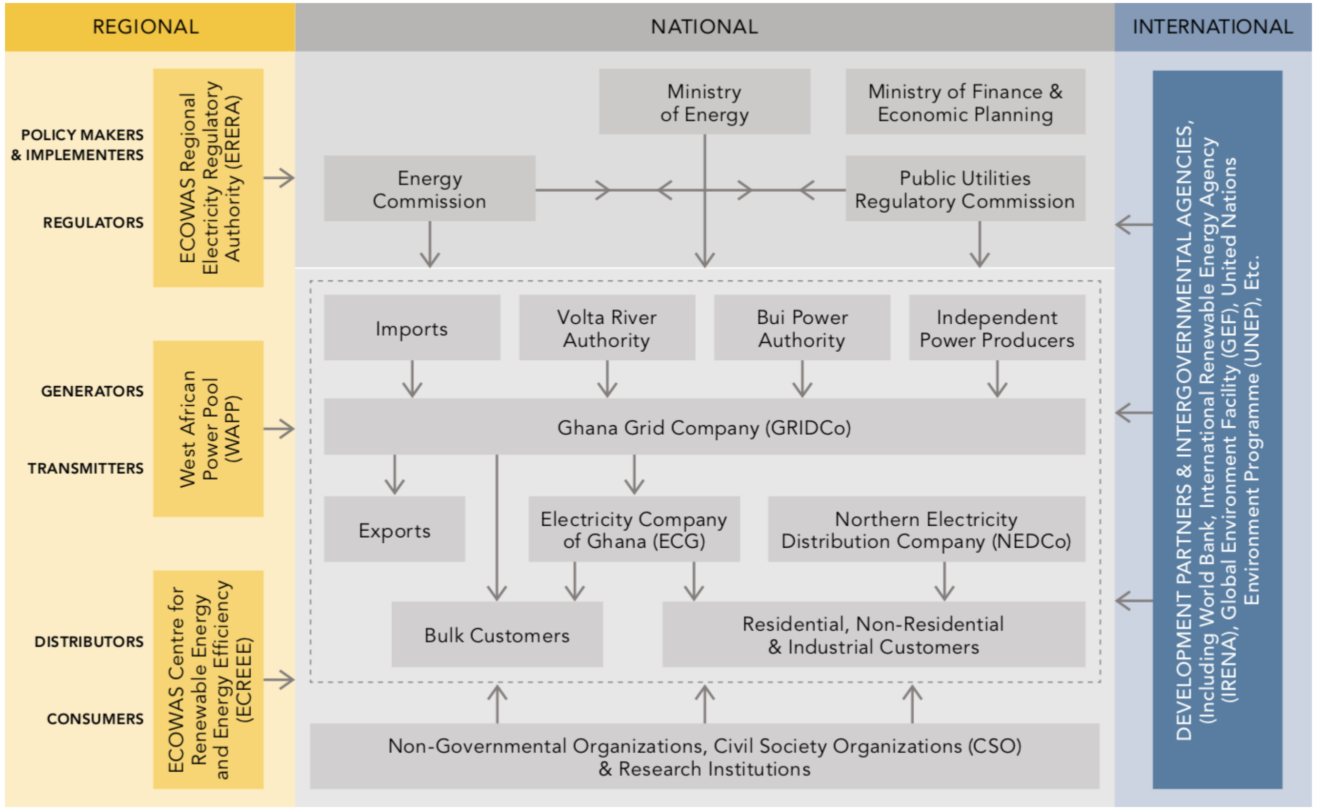
Energy policy and regulatory framework

Legal Framework for Clean Captive

- **Renewable Energy Act, 2011**
  - Feed-in tariff scheme
  - Renewable purchase obligation
  - Net metering
  - Off-grid electrification
- **Renewable Energy Master Plan**

Licensing for Clean Captive

- Rooftop / Small-scale renewable mini-grid electricity sales
- Wholesale electricity supply
- Manufacturing and assembly
- Importation, installation and maintenance of renewable energy technologies
- Lease-to-own license

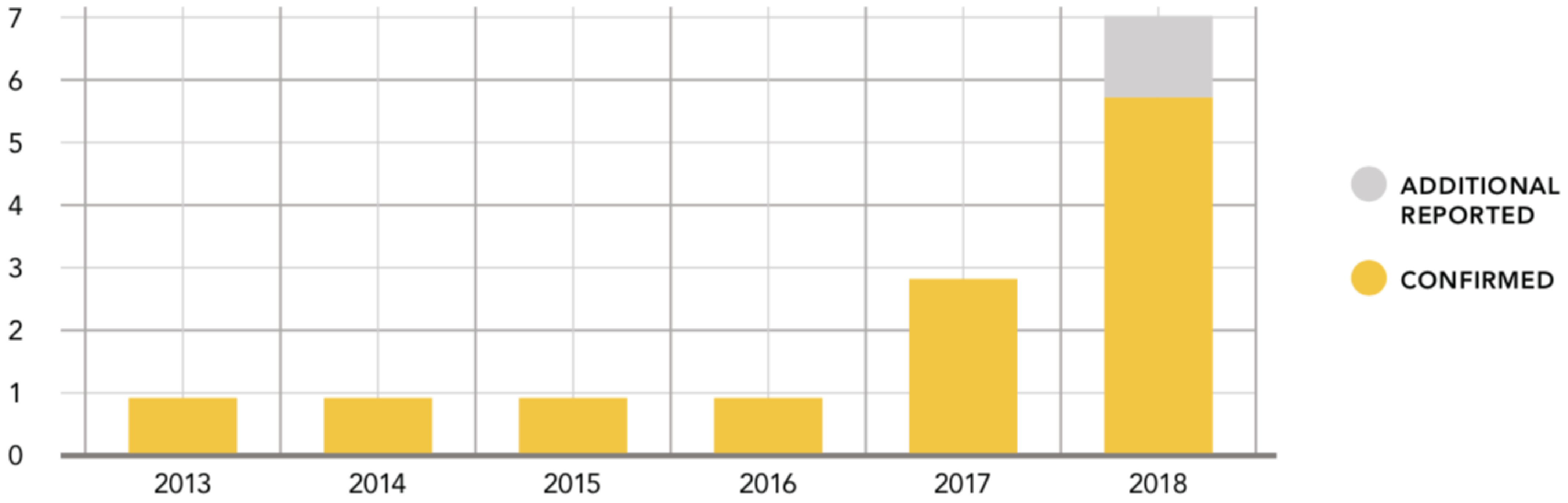


Uncertainties remain around the issuance of the different kinds of licenses to implement the clean captive solution.

Country study | Ghana

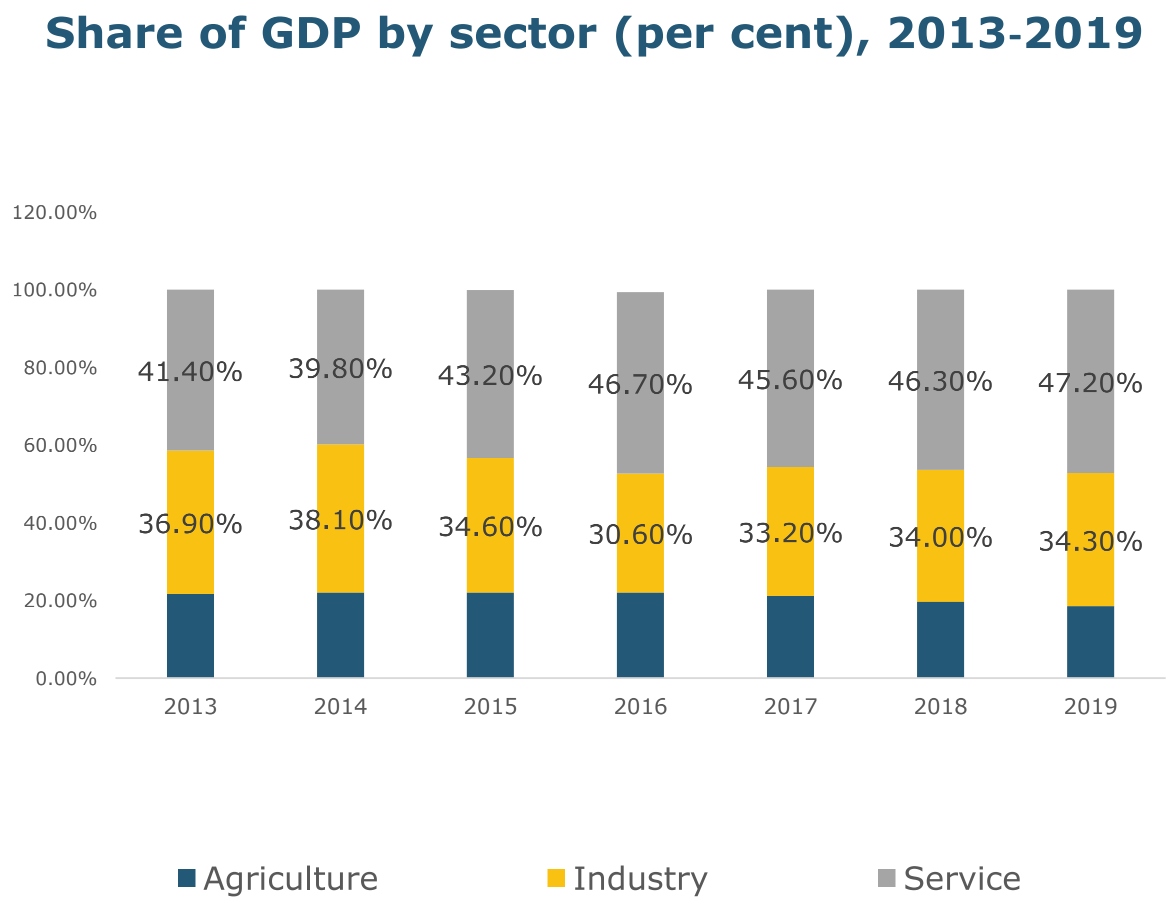
Overview of existing renewable energy captive installations

Commercial and industrial solar installed capacity (MW) in Ghana, 2013-2018



Country study | Ghana

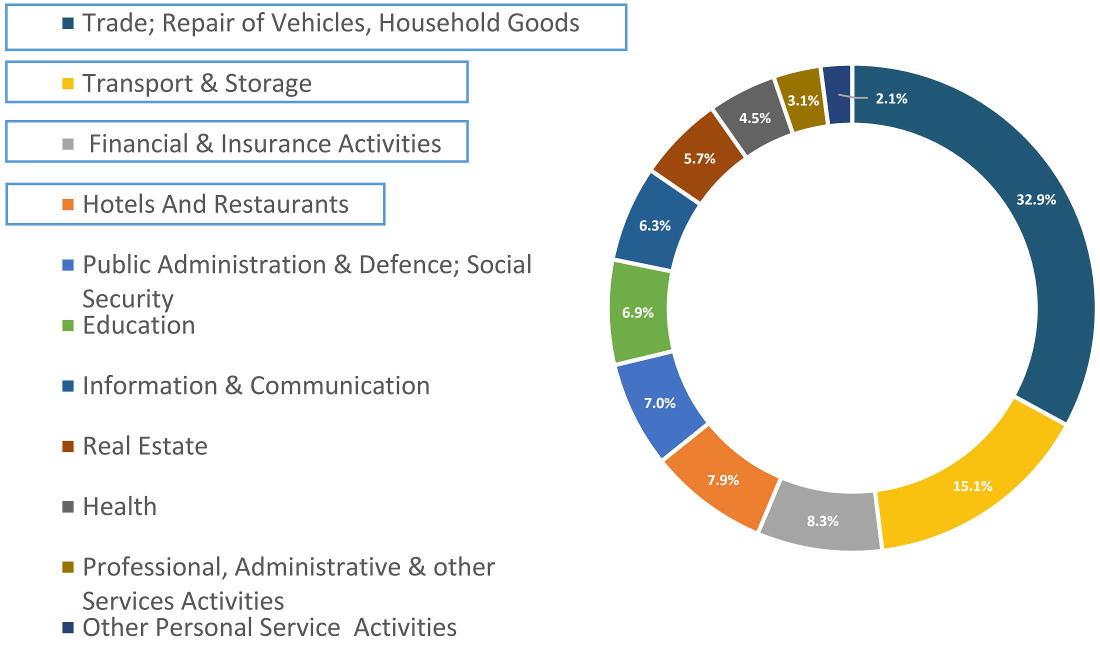
Ghana market potential for captive power



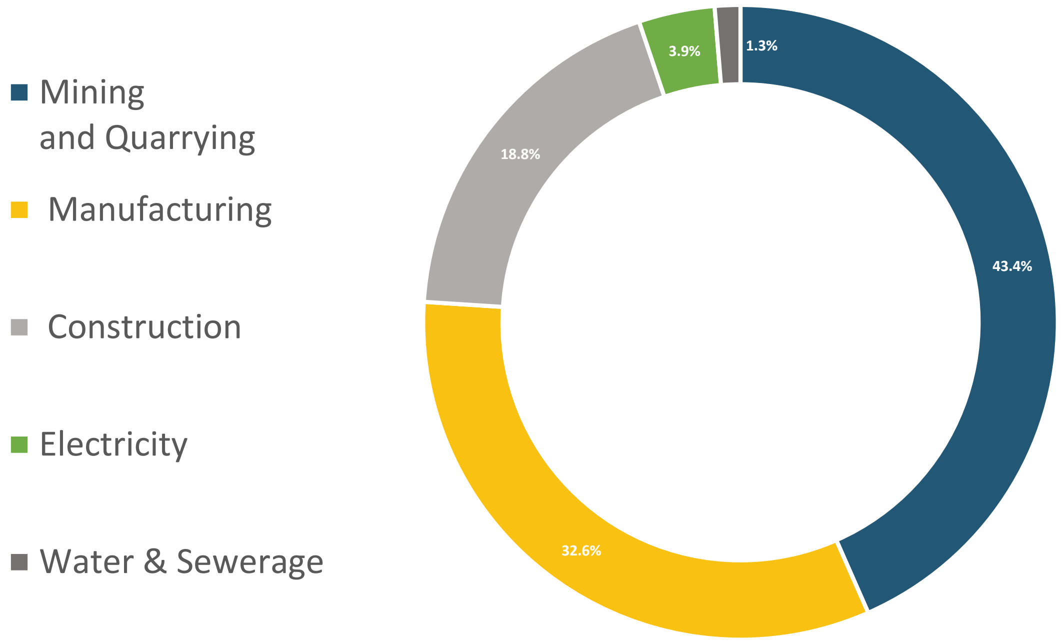
Country study | Ghana

Ghana market potential for captive power

Service sector by value-added activities



Industry sector by activities



Country study | Ghana

Financing clean captive power – Commercial Banks

- Annual interest rates of between 23 per cent and 27 per cent (in Ghanaian Cedis)
- Short tenors of between two and five years

Examples of concessional lines of credit to support lending to the sector:

Bank name	Type	Partner institution	Facility amount	Denomination / Expected interest rate / Tenor	Status
CalBank	Renewable energy	Agence Française de Développement (AFD)	$20 million	U.S. dollars / 10% Minimum 5 years	Approved July 2019
	Renewable energy	International Finance Corporation	$12.5 million	U.S. dollars / 10% Ghanaian cedis / 22-25% Minimum 5 years	Approved May 2018
Ecobank	Renewable energy	Green Climate Fund – Accredited Entity	Not disclosed	U.S. dollars / unknown For projects approved for Green Climate Fund funding 3% Tenors unknown	NA
Fidelity*	Blended, water sanitation and health care	SNV (Netherlands Development Organisation)	Not disclosed	Ghanaian cedis / 10% for water and sanitation projects 22% for healthcare projects 36 months tenor	Approved
Stanbic	Renewable energy	AFD	€10 million	Ghanaian cedis / 13-19% 15 years	Approval in final stages

Financing clean captive power – Private financiers

Selected captive PV financing firms / energy service companies active in Ghana

Berkeley Energy focused on only 300 kWp solar PV grid-connected and hybrid solutions in Ghana, it acquired Azimuth Power's operations and business in Ghana in 2019.

Crossboundary Energy has installed a 400 kWp solar PV system on the rooftop of Kasapreko Company Limited in Accra and is constructing a 999 kW rooftop solar PV system for a multinational in Tema.

Dutch & Co- Has undertaken a number of projects across banks, retail, mining and hospitality. It has an installed capacity of 1,400 kWp, completing about nine projects in a number of sectors with project sizes from 16.5 kWp to 565 kWp.

REDAVIA Solar Power - As of 2019, it had installed more than 10 systems in Ghana, ranging from 40 kWp to 800 kWp for manufacturing companies, universities, etc., for a total installed capacity of 3-4 MW.

Translight - focused only on the supply of back-up systems during Ghana's energy crisis period (2013-2015). From 2016, the company added development of solar PV modules for both off-grid and grid-connected solutions for its clients. The largest project installed to date had 300 kWp capacity.

Yingli- delivers projects with both equity and debt financing. Acts as the operations and maintenance for the projects and works with Ghana Power Scientific as its installation partner. Has completed 5-6 projects to date including Kasapreko and 3 branches for Stanbic Bank.

DSE Group -specializes in energy efficiency through LED (light-emitting diode) lighting and solar PV installations, ranging from small residential to large-scale industrial systems. In Ghana, the group has installed a 350 kWp solar plant for a meat company, a 106 kWp solar facility for a pharmacy and 565 kWp on a cocoa factory.

Conclusion

- **Electricity supply reliability is rather low** due to high levels of transmission and distribution losses in Ghana. → **captive power** is seen as an alternative private sector solution to address the challenges of the unreliability of power supply.

- Ghana had the **highest electricity tariffs for commercial and industrial facilities** in Sub-Saharan Africa. → the expected levelized cost of electricity for captive solar generation seems to be very cost competitive and attractive for commercial and industrial consumers.

- The **sub-sectors in the service and industry sectors** in Ghana have been identified as strong potential sectors for clean captive power. → Any **cost reduction through lower electricity bills** would help reduce expenses and improve competitiveness.

- The uncertainty surrounding the country's **energy regulatory framework and financing** of clean captive installations in Ghana are **main obstacles** in the uptake of clean captive installations. → **better transparency** in the regulatory environment and the presence of an **active financing ecosystem** will be conducive.

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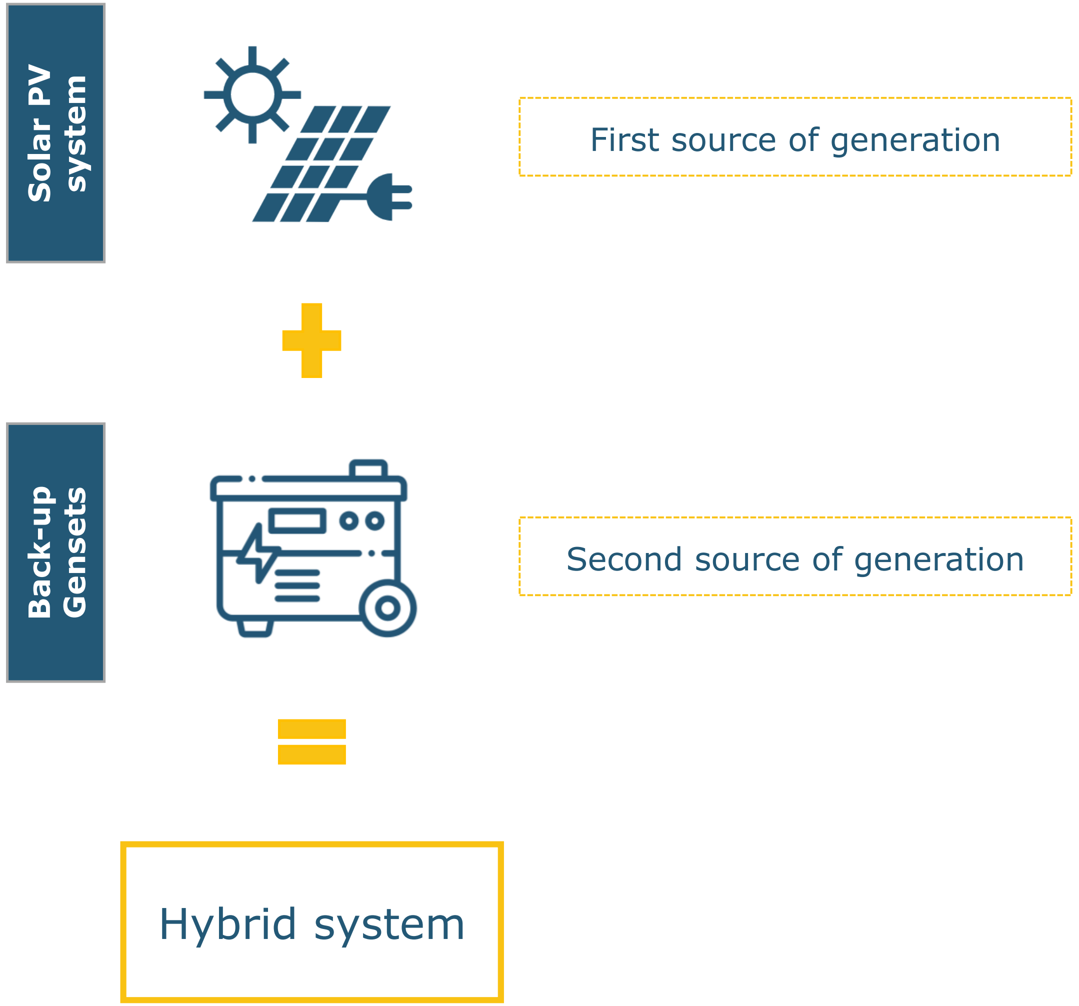
Tool 4 | Best Available Technology (BAT) for solar PV captive systems

The Hybrid system

- **Hybrid systems** consists of more than one source for energy generation
- Most common is **solar PV/diesel** hybrid system
- Combines generation from **solar PV** and **Gensets**
- Can be either **on-grid** or **off-grid** systems

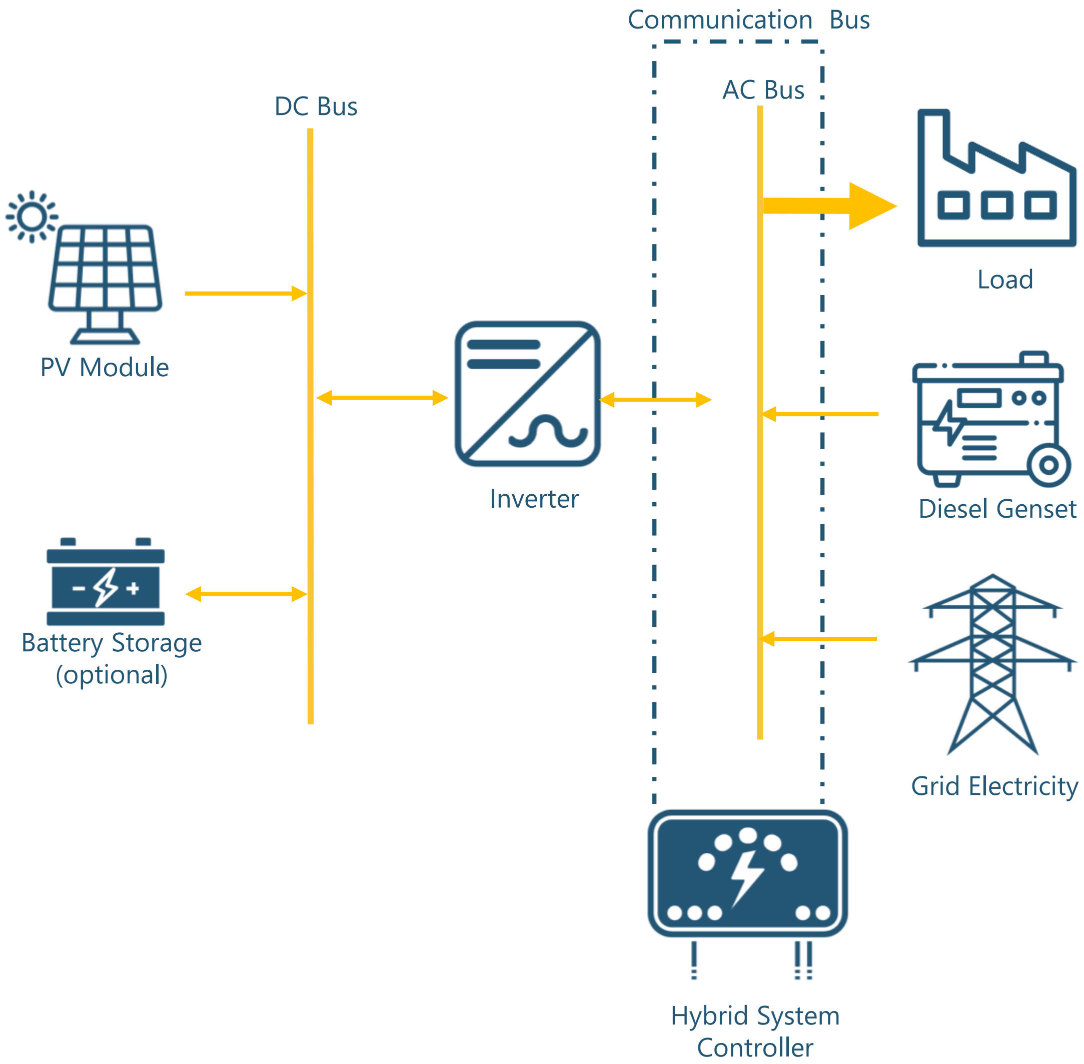


Tool 4 | Best Available Technology (BAT) for solar PV captive systems

The Hybrid system

Hybrid system main components:

- Solar PV panels
- Inverters
- Gensets
- Hybrid system controller
- Battery storage (optional)



Tool 4 | Best Available Technology (BAT) for solar PV captive systems

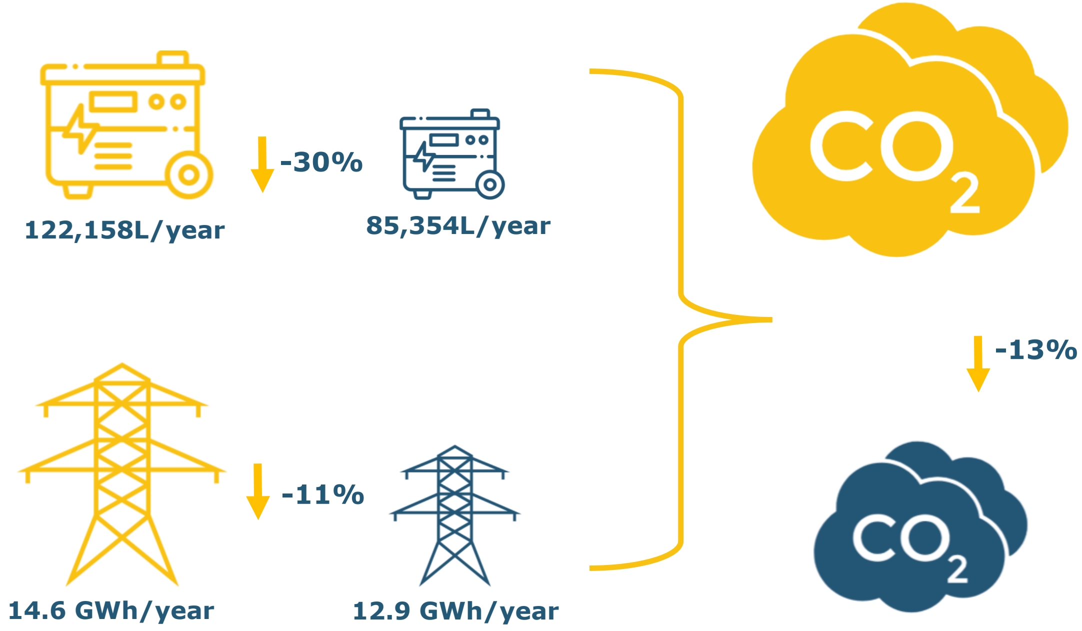
The Hybrid system

There are many **benefits to hybrid systems** such as:

- Fuel savings
- Grid purchases savings
- Reliability of power supply
- Reduction in CO2 emissions
- Battery storage

Example:

- Factory based in Nairobi Kenya
- Operates on 24/7 basis
- Has five installed Gensets and utilizes three of them



Tool 4 | Best Available Technology (BAT) for solar PV captive systems

The Hybrid system

NOTE: Ensure that product warranties are provided by the respective supplier

Product Data Sheet

Solar PV panel

- Efficiency ≥ 18%
- Degradation rate ≤ 0.7%
- Temperature coefficient range: -0.3% to -0.5%
- Power Tolerance: 0/+3%
- Life cycle: 20 -25 years

Inverter

- Efficiency ≥ 95%
- The DC to AC conversion losses: 2-5%
- Life cycle: 8 to 10 years

Battery Storage

- Efficiency ≥ 85%
- Depth of discharge (DOD) ≥ 80%
- Most used type: lead-acid
- Life cycle: 8 to 10 years

Hybrid system controller

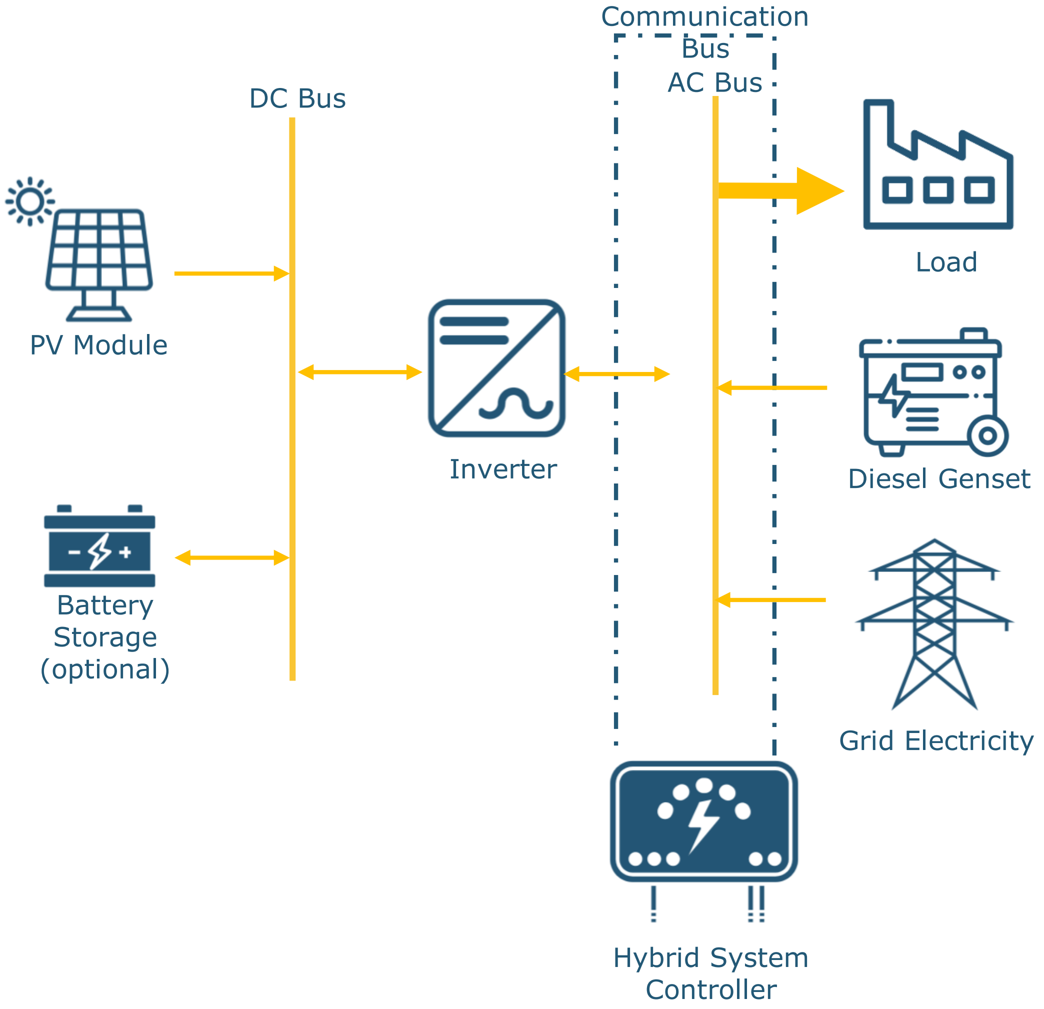
- Energy management system
- Ensure compatibility with Gensets and inverters

Tool 4 | Best Available Technology (BAT) for solar PV captive systems

The Hybrid system

Ensuring a proper design

- Proper sizing of the system
- For on-grid systems, the system should be in accordance to the local grid requirements
- Performance ratio ≥ 80%
- Ensuring minimum load factor of Gensets is met
- Minimizing shading losses ≤ 1% to 4%
- Roof installations should comply with the local legislation
- Maintenance and cleaning plan to reduce soiling losses



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Tool 2 | Cost benefit analysis of RE projects

Introduction

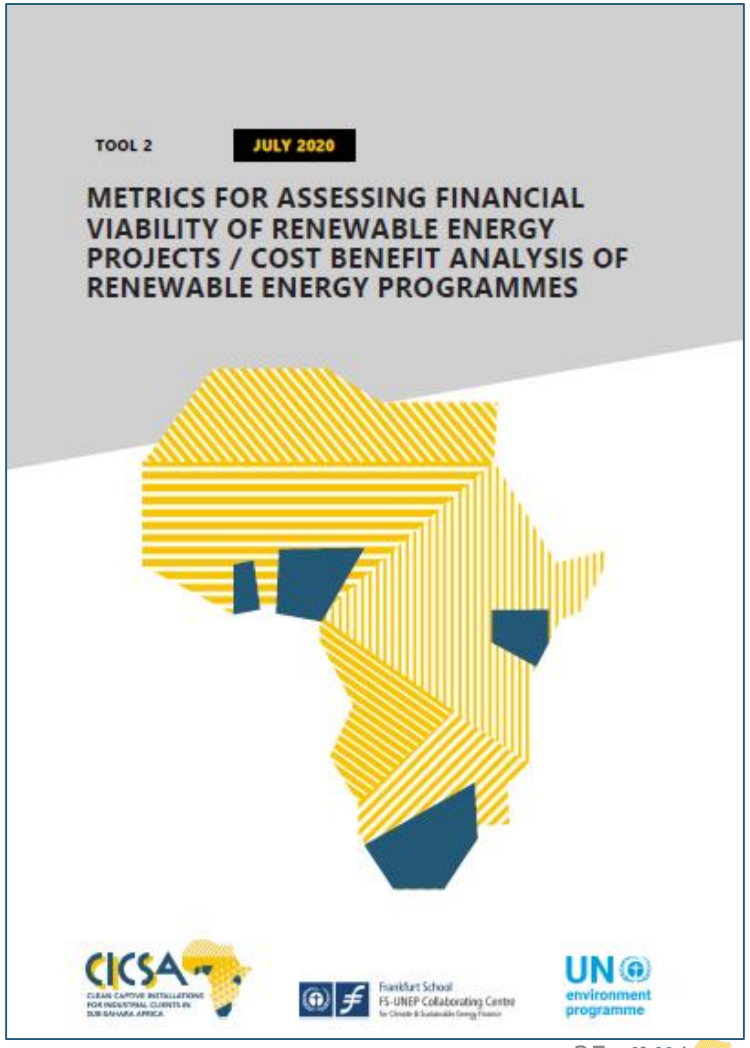
Content of the Tool

Introductory guidelines on metrics and considerations for analyzing the attractiveness of individual renewable energy projects such as solar PV captive systems

- Perspective of the analysis: **public or private**

Target Audience

Stakeholders such as investors, policy makers and analysts by providing them with analytical considerations that are commonly required for a complete assessment of RE investments



Tool 2 | Cost benefit analysis of RE projects

Steps to evaluate projects

Define the relevant aspects

- **Perspective of the analysis**
- Risks and minimum required return
- Investment horizon
- Real options

Identify the relevant flows and impacts

- Differential
- Sunk costs

Estimate metrics

- NPV
- IRR
- Payback
- Benefit to Cost ratio
- Others

Conduct sensitivity/ scenario analyses

Tool 2 | Cost benefit analysis of RE projects

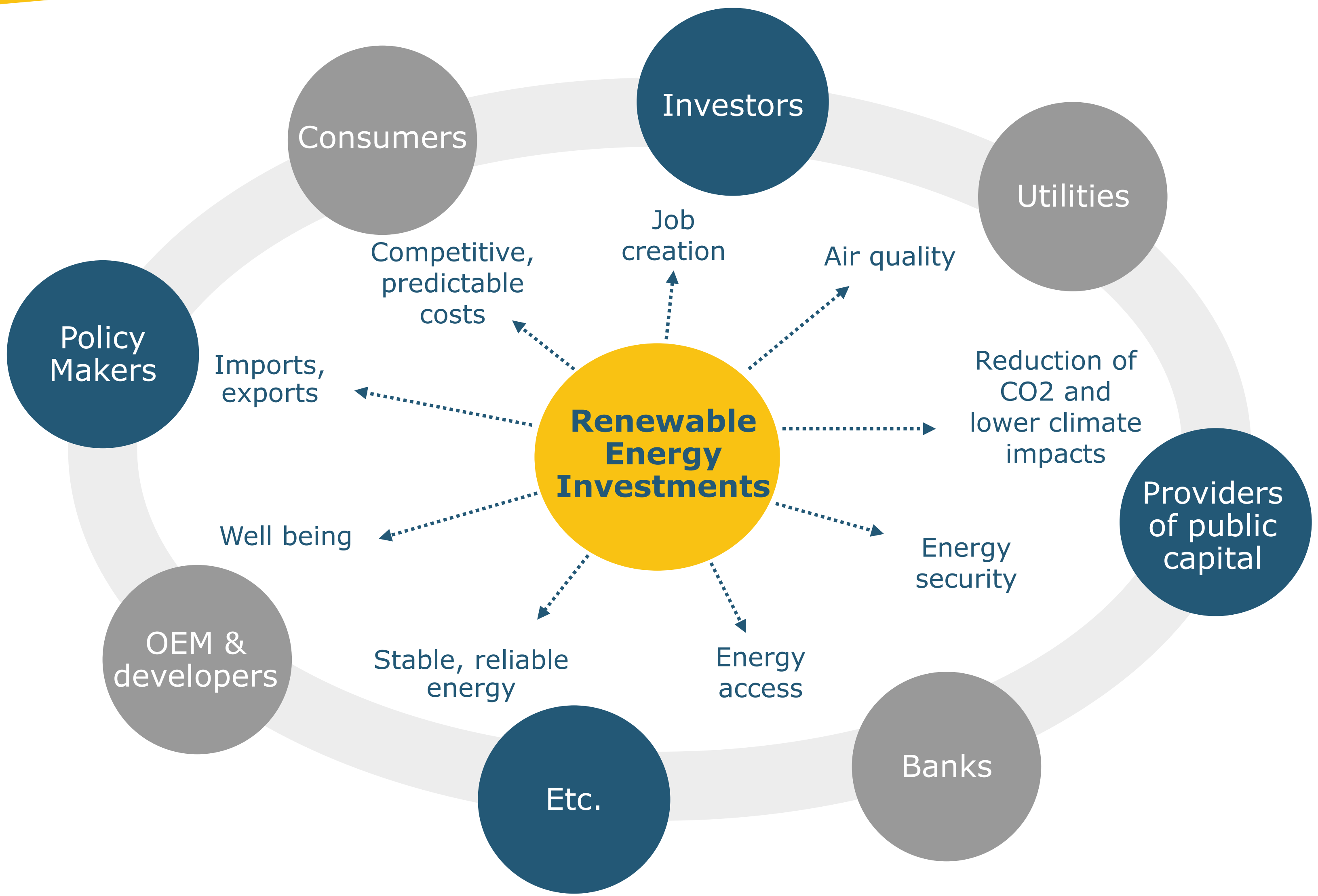
Analysis from various perspectives

	Public Sector	Private Sector
Beneficiaries	Society	Investor(s) (equity, debt, project)
Timeframe	Technological lifetime	Investment horizon
Costs and benefits	All economic, social and environmental impacts are considered, including external and indirect impacts	Only relevant costs and benefits that directly impact cash flows are considered
Discount rate used	Social discount rate (lower than private investors' required return)	Minimum required rate of return of the investor
Relevant Metrics	Benefit to Cost Ratio NPV LCOE	IRR NPV Payback period LCOE

Source: Frankfurt School Analysis, RETD 2013

Tool 2 | Cost benefit analysis of RE projects

Public perspective



Tool 2 | Cost benefit analysis of RE projects

RE systems benefits

	Associated benefits of PV (non-exhaustive)
Ghana	▪ Increased **energy self-sufficiency** of consumers (reduced **production costs** and losses) ▪ **CO_2 emissions** reduction ▪ Contribution to the **country CC objectives**
Kenya	▪ Reduction of **technical energy losses** in the grid ▪ **Demand curve flattening** ▪ Reduction of **infrastructure investments** ▪ **CO_2 emissions** reduction ▪ **Cost savings**
Nigeria	▪ Increased energy **self-sufficiency** of consumers (reduced **diesel costs** and **production losses**) ▪ Positive **health impacts** and **increased well-being** ▪ More stable **network infrastructure**
South Africa	▪ **CO_2 emissions** reduction ▪ Less **pressure on the current power infrastructure**

Source: Frankfurt School Analysis

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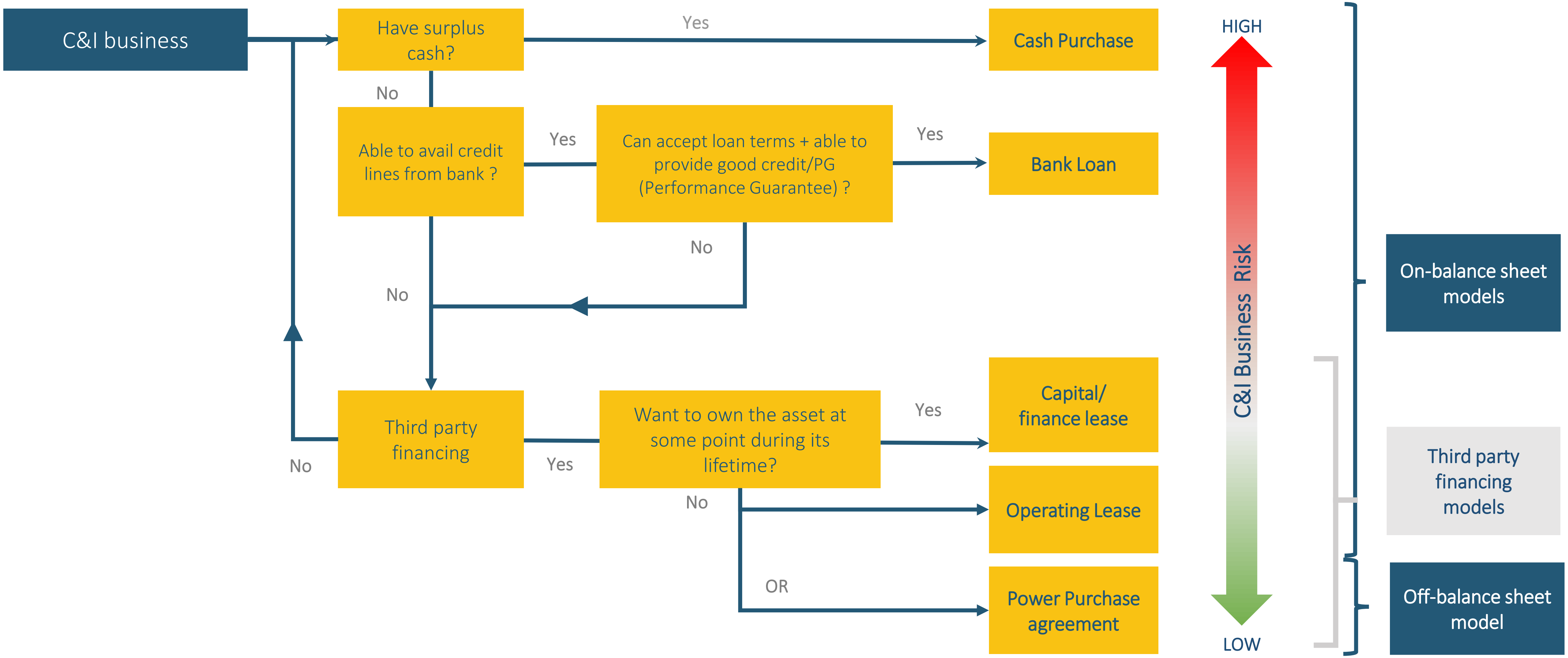
Tool 1 | Financing guidelines & business models for solar PV captive systems

Understanding business models

	Business models (off-taker perspective)	Pros and cons of each business model	
On-balance sheet	**Ownership model** ▪ Outright asset purchase with cash (equity) or bank loan	✓ Retain ownership and control of asset ✓ Less complex structuring ✓ Develop internal expertise	✗ Risks (operational & financial) borne by C&I business ✗ Competition with alternative investment decisions/options
Third party financing	**Leasing model (fixed payments)** ▪ Capital lease (lease-to-own) ▪ Operating lease **PPA model (payment per kWh)**	✓ Lower upfront costs/financial barriers to entry ✓ No direct O&M responsibilities ✓ Project performance risks (most) are borne by developer/EPC	✗ Complex project structuring ✗ Higher transaction costs ✗ Not much flexibility (in terms of re-negotiation or termination) once contract is effective

Tool 1 | Financing guidelines & business models for solar PV captive systems

Choosing the right business model



Tool 3 | Preliminary financial model for viability assessment

Creating the input sheet

Objective of modelling: Conduct financial assessment of the PV project and illustrate the financial viability

System costs

- Cost of the system including breakdown (panels, inverters, controllers, mounting structure, cabling, installation, etc.)

Usage patterns

- % of solar consumption
- % of consumption used for net metering
- % of solar generation from Gensets
- % of solar generation lost

Technical solar specs

- System size identification
- Generation utilization and total generation potential

Financing costs

- Total financing rate (WACC)
- Tenor of the loan
- Down payment amount

Electricity prices

- Grid tariff rates
- Back-up generation costs
- Net-metering benefits
- Future price increase

Other parameters

- Corporate tax
- O&M

Tool 3 | Preliminary financial model for viability assessment

Drivers of profitability

System costs	**CAPEX**
Technical solar specs	**Solar irradience, EPC and O&M contractors**
Electricity prices	**LCOE, leasing contracting, PPA contracting**
Usage patterns	**Demand or load curve**
Financing costs	**WACC (cost of debt, loan tenor, cost of equity)**
Other parameters	**Regulations (net-metering, legality of PPA)**

Tool 3 | Preliminary financial model for viability assessment

Model overview

Microsoft Excel Worksheet

Input Sheet

1. Assumption for grid electricity
- Electricity prices

2. Assumption for solar system
- System assumption
- System usage

3. CAPEX and OPEX assumption
- System costs per KWp
- Replacement CAPEX
- Depreciation

4. Financing assumption
- Cost of equity and debt
- Loan tenor
- Corporate tax

5. Other assumptions
- CO2 savings

6. Solar Production profile

Output Sheet

- **IRR (Project and Equity)**
- **NPV of cash flows (Project and Equity)**
- **LCOE**
- **DSCR**
- **Simple payback period**
- **CO_2 emission savings**

Sensitivity sheet

- The sensitivity sheet provides impact on an output by varying model inputs
- In doing so, the user will be able to simulate some uncertainties in the input values of the model, hence helping to make informed decisions
- This helps assess risks of a certain project

Webinar | Summary of key takeaways

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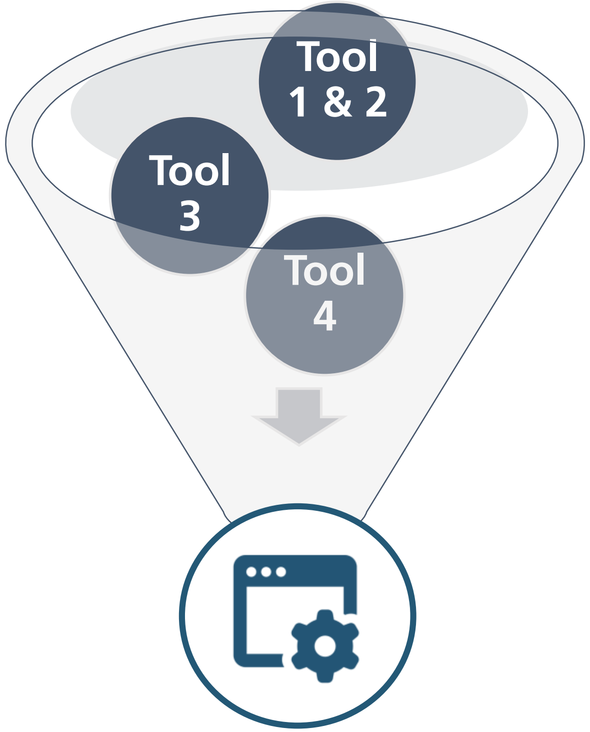

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Thank you for your patience!

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UN Environment (UNEP)


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