CICSA
CLEAN CAPTIVE INSTALLATIONS FOR INDUSTRIAL CLIENTS IN SUB-SAHARA AFRICA

Clean Captive Installations in sub-Sahara Africa

Webinar | Session 2

Summary of the Kenya country study and Tools

FS-UNEP Collaborating Centre

16th September, 2020 | 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

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5 minutes	**WELCOME** Introduction to Webinar Session 2	**TOBIAS PANOFEN** (FS-UNEP Collaborating Centre) 
15 minutes	**KENYA COUNTRY STUDY REPORT** Overview of Kenya Energy sector and its potential for Clean Captive Power Installations	**HIND II-IDRISSI** (UNEP) 
50 minutes	**INTRODUCTION TO THE CCI TOOLS**	
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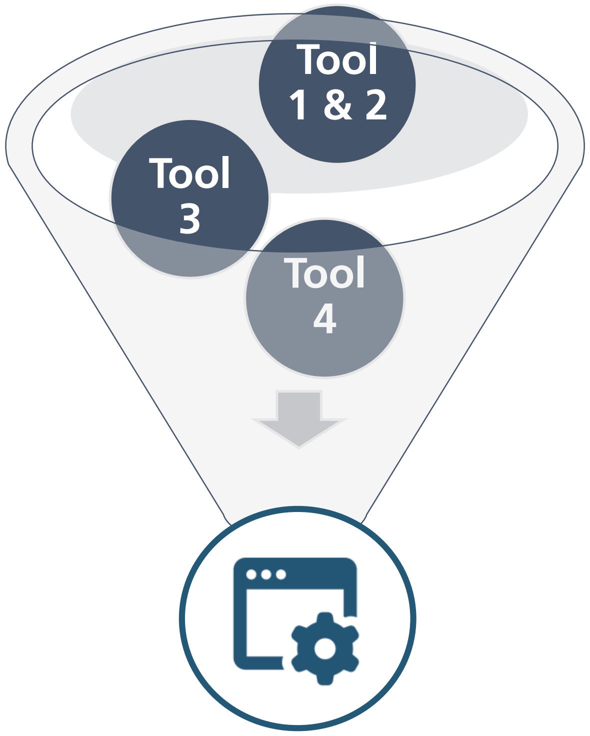
Webinar | Introduction

Session 2

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

Session 2:
Overview of the Kenya 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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Introduction

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

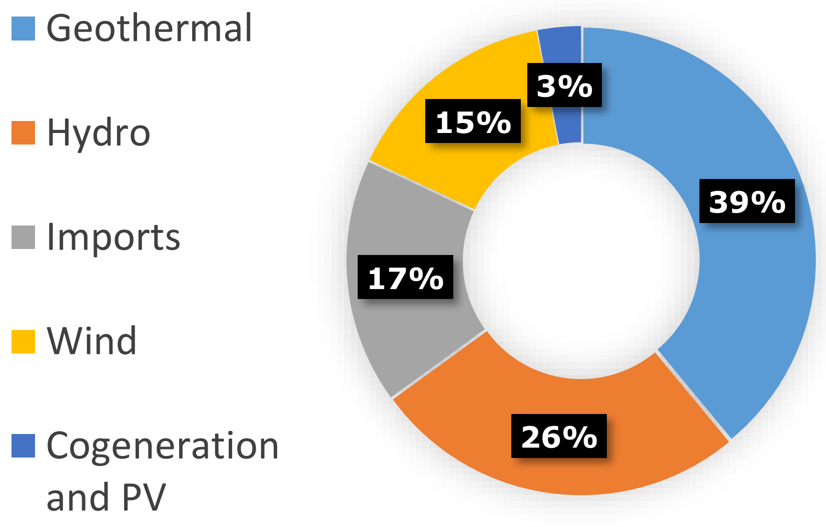
Download from website:
captiverenewables-africa.org/publications/

Country study | Kenya

Energy profile

Kenya power sector has been undergoing reforms in recent years aimed at accelerating sectoral development

Energy indicator	Result
Access to electricity	75%
Electrification – urban areas	81%
Electrification – rural areas	58%
Average cost of generation	US$ 0.11 per kWh
Electricity consumption	8 435 GWh
Electricity exports	24 GWh
Electricity imports	171 GWh
Electricity total installed capacity	2 716 MW



Country study | Kenya

Energy market

- The total number of KPLC customers in the commercial and industrial (CI) tariff categories **was 3,912 in June 2018**

- Average consumption in megawatt-hours (MWh) per customer ranges **from 493 MWh for CI1 customers to 10,849 MWh for CI4 customers.**

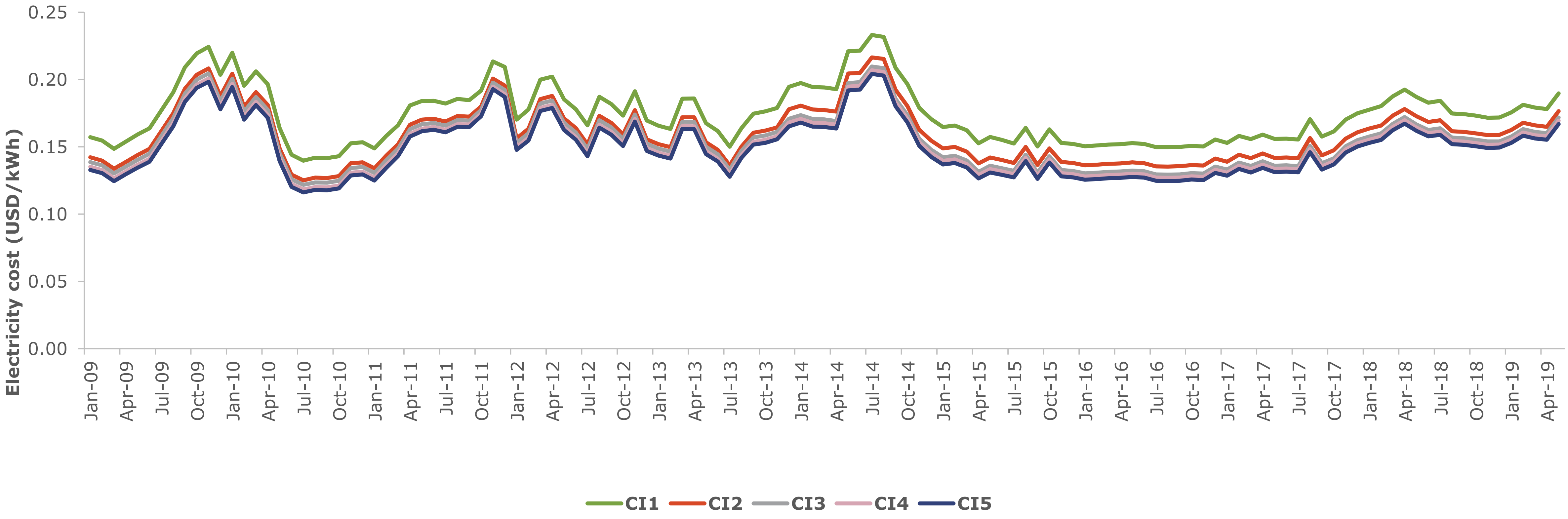
TARIFF CATEGORY	CONNECTION VOLTAGE	VOLTAGE CATEGORY*
CI1	415 V	Low
CI2	11 kV	Medium
CI3	33 kV	
CI4	66 kV	High
CI5	132 kV	

- **Kenya experiences frequent grid down time** due to weather conditions, equipment failure, vandalism and planned interruptions
- **More than 80%** of 1,011 surveyed **manufacturing & service firms reported power outages** on an **average of 3.8 times per month.** These outages lead to **losses equivalent to 5.4% of annual sales**

Country study | Kenya

Electricity tariffs

Historic electricity prices for C&I tariff categories including surcharges



Country study | Kenya

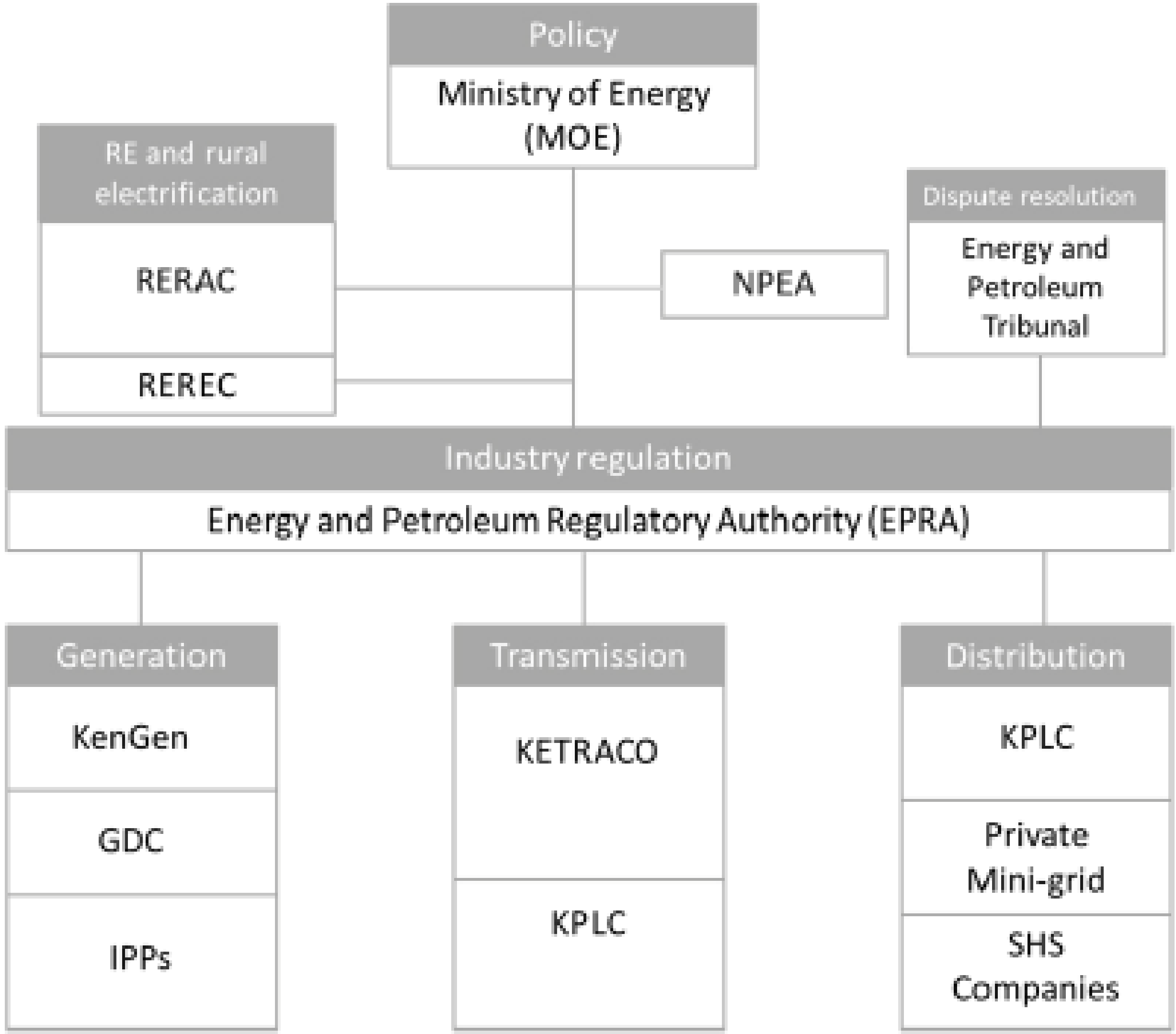
Regulatory and institutional framework

Policies:

- National Energy Policy, 2018
- **Energy Act of 2019**
- Feed in Tariff, 2012
- Energy Auction Policy (draft)

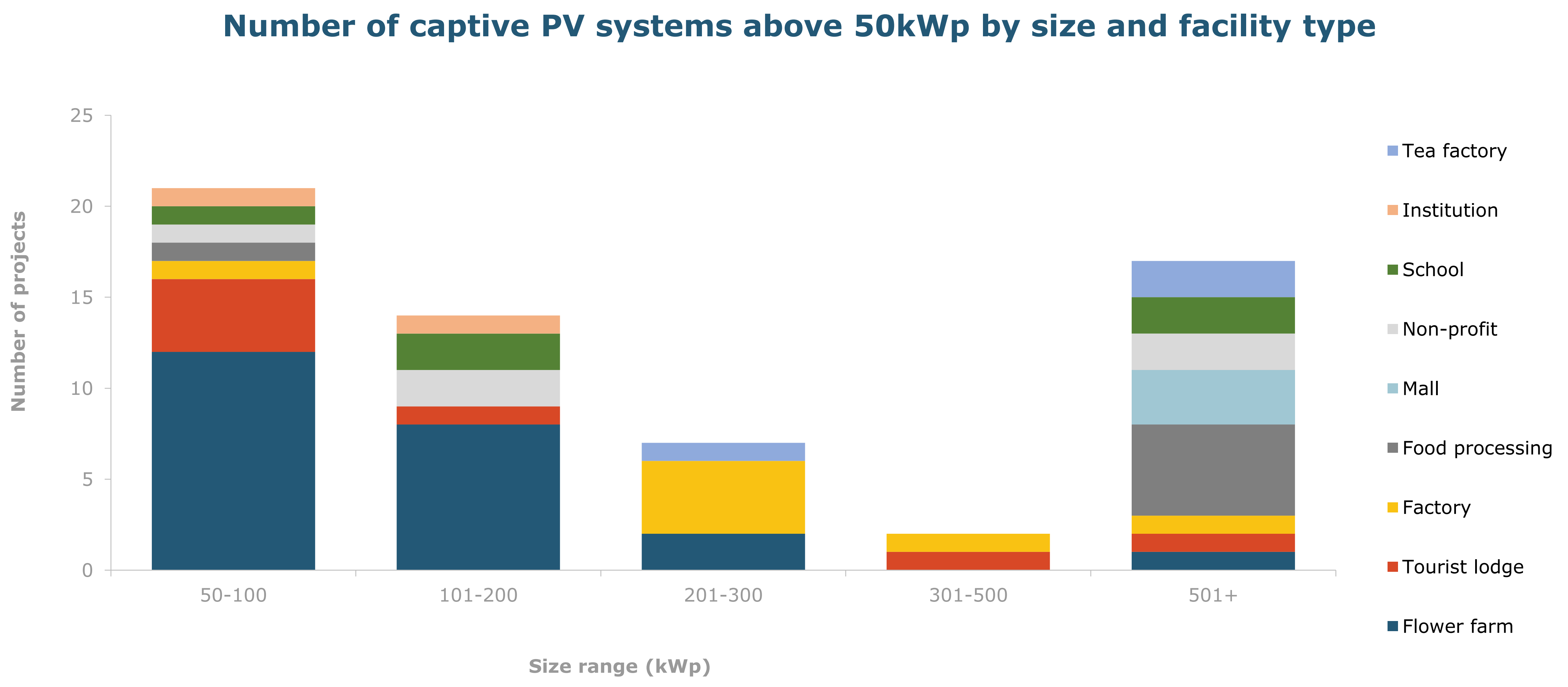
Regulations:

- **Energy Regulations 2012**
- Energy Management Regulations, 2012
- Energy Solar PV Regulations, 2012
- Kenya National Distribution Code



Country study | Kenya

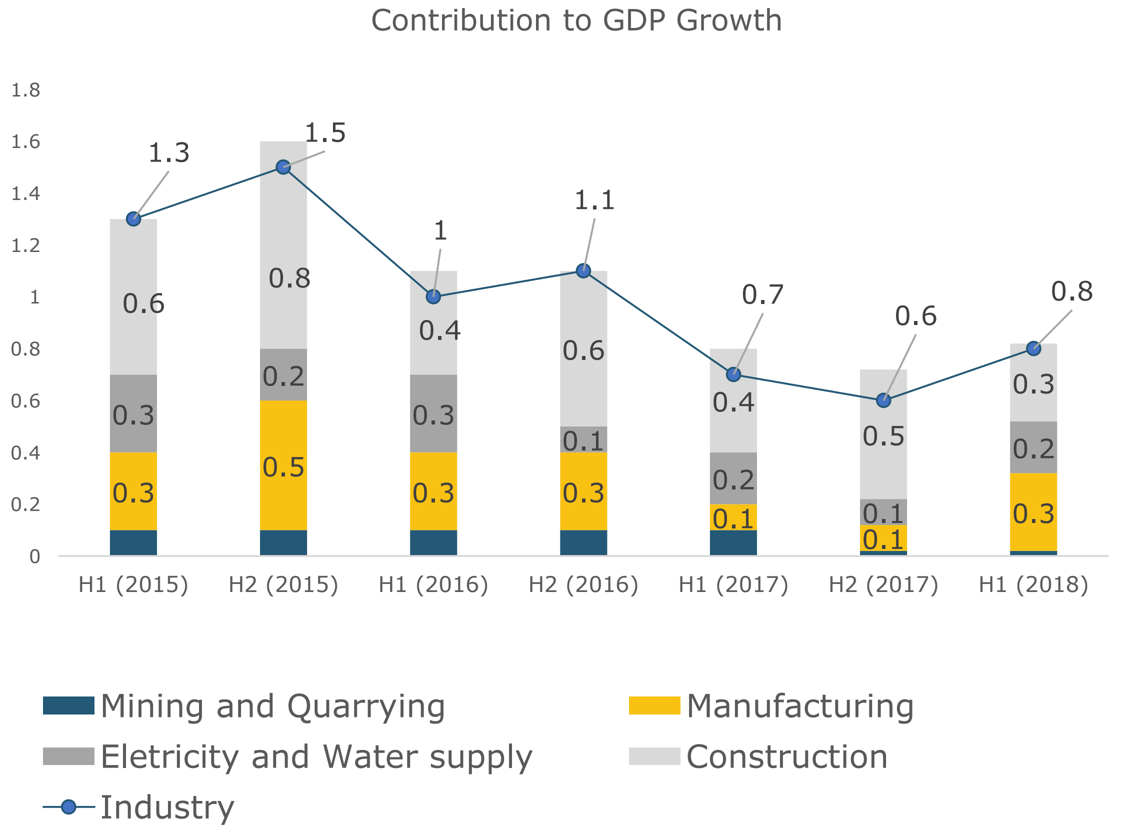
Overview of existing renewable energy captive installations

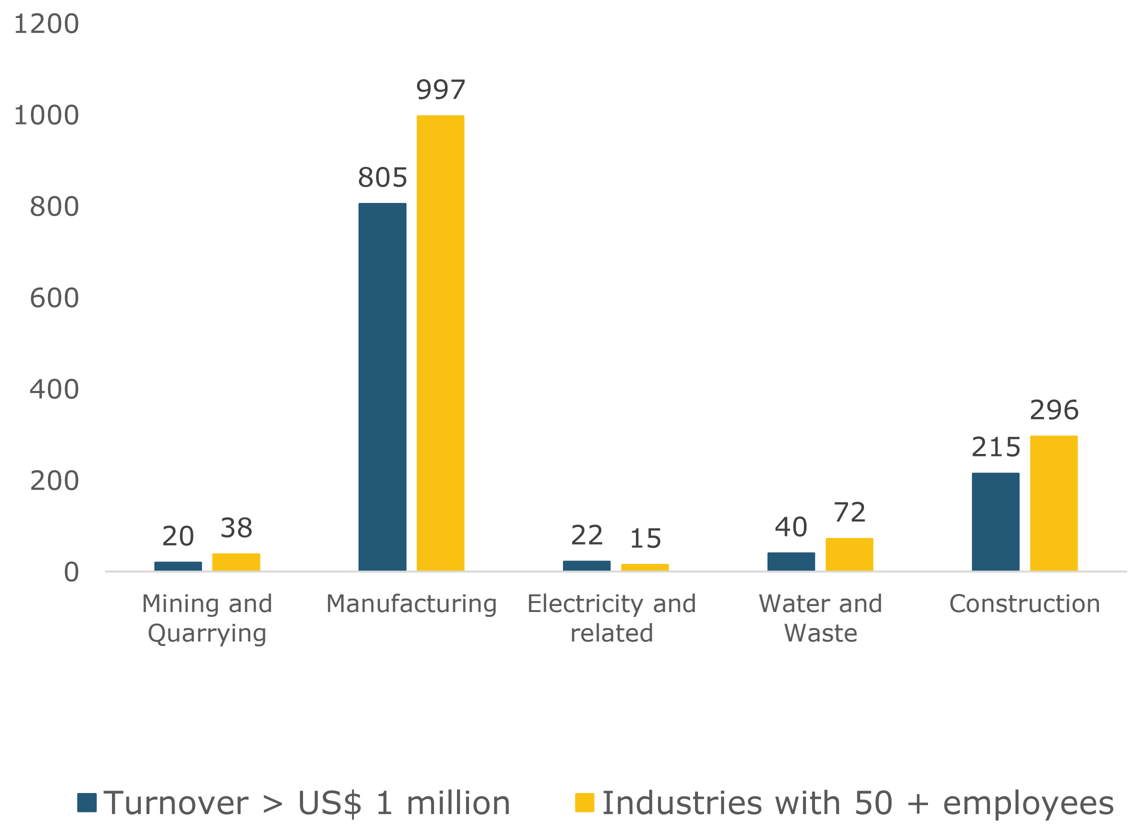


Country study | Kenya

Potential of the Industrial Sector

Overview of main industrial sub-sectors





Country study | Kenya

Potential of the Industrial Sector

Identified industrial sub-sector with high potential for clean captive

Economic Sub-sector	Turnover exceeds US$ 1 million	Potential level
Mining and Quarrying	Only 20/ 297 businesses had a turnover of more than US$1 million.	Low Potential (5-15 users)
Manufacturing	805 manufacturing entities had turnover exceed US$ 1 million	High Potential
Electricity and related	Only 22/ 84 entities in the related sector had an assumed turnover of more than US$1 million.	Low Potential
Water and waste	Only 31/ 205 entities had turnover exceeding US$1 million	Low Potential (most of these entities are likely publicly owned)
Construction	Only 215/ 11,843 active entities had annual revenue of more than US$ 1 million	Low potential (firms are expected to be either office-based or construction sites

Country study | Kenya

Commercial bank financing

- In Kenya, only a few banks are involved in financing C&I RE captive power installations
- Lending to clean captive power projects is limited and perceived as high risk:
  - *Interest rate cap → thus reduced the bank's headroom for structuring finance deals with SMEs*
  - *Risk-averse local banking sector with limited experience in financing corporate energy projects*
  - *Foreign currency risk*
- Three active banks are Diamond Trust Bank, Commercial Bank of Africa and Co-operative Bank of Kenya
- Development cooperation partner programmes supporting financing of clean captive power:
  - ***SUNREF***
  - *Joint Crediting Mechanism*
  - *Powering Agriculture*
  - *Green bonds*

Country study | Kenya

Private financiers

Main captive PV financing/ESCO firms active in Kenya

Ariya Capital - Provides leasing finance and fund management, and invests in IPPs. On the leasing side, has partnered with African Solar Designs

Crossboundary Energy - Finance and manage 1.5 MW of captive PV in Kenya to date. Has a partnership with leading EPC Solarcentury

Ecoligo - Crowd-funded debt sourced in Euros for individual projects under leasing/PPA. Financed 700-plus kW in Kenya. Often works with Kenyan EPC Harmonic Systems

Faber Capital - Part of an international group of companies, including Premier Solar Solutions (Kenyan EPC), and can offer financing.

Maris - Diversified holding company. Co-owns Equator Energy (Kenyan/German EPC), which enables EPC to offer financing.

responsibility - Global development fund manager with more than US$3 billion of assets under management. Has a renewable energy project development arm in Kenya. Has financed a captive power developer in Ghana but not in Kenya (yet).

SolarAfrica/ NVI Energy - Captive PV financing platform and partner of Crossboundary

Solarise Africa - Private financier and ESCO. Has financed up to around 3 MW of solar PV in Kenya. Offers turnkey solutions under three types of long-term flexible funding solutions: asset financing, operating lease (with ownership option) and PPA. Partner of Premier Solar Solutions (Kenyan EPC).

SunFunder - Provides exclusively debt. Established US$1.2 million working capital debt facility for Questworks (Kenya developer/EPC) in June 2018.

Country study | Kenya

Conclusion

- **Kenya experiences frequent grid down time** due to weather conditions, equipment failure, vandalism and planned interruptions. This results in annual sales losses for the C&I sector.
- Retail tariffs are likely to go up based on forecasts → **PV plants with levelized costs will be attractive to a number of industrial users**
- Captive plants <1MW installed capacity and 100% self-consumption **do not require any electricity licensing** or energy regulatory approval
- At least 100 captive power solar PV systems above 10-15 kWp at commercial, industrial and institutional/ non-profit establishments constructed or under construction
- There is an **active ecosystem of financiers and developers for clean captive installations in Kenya**

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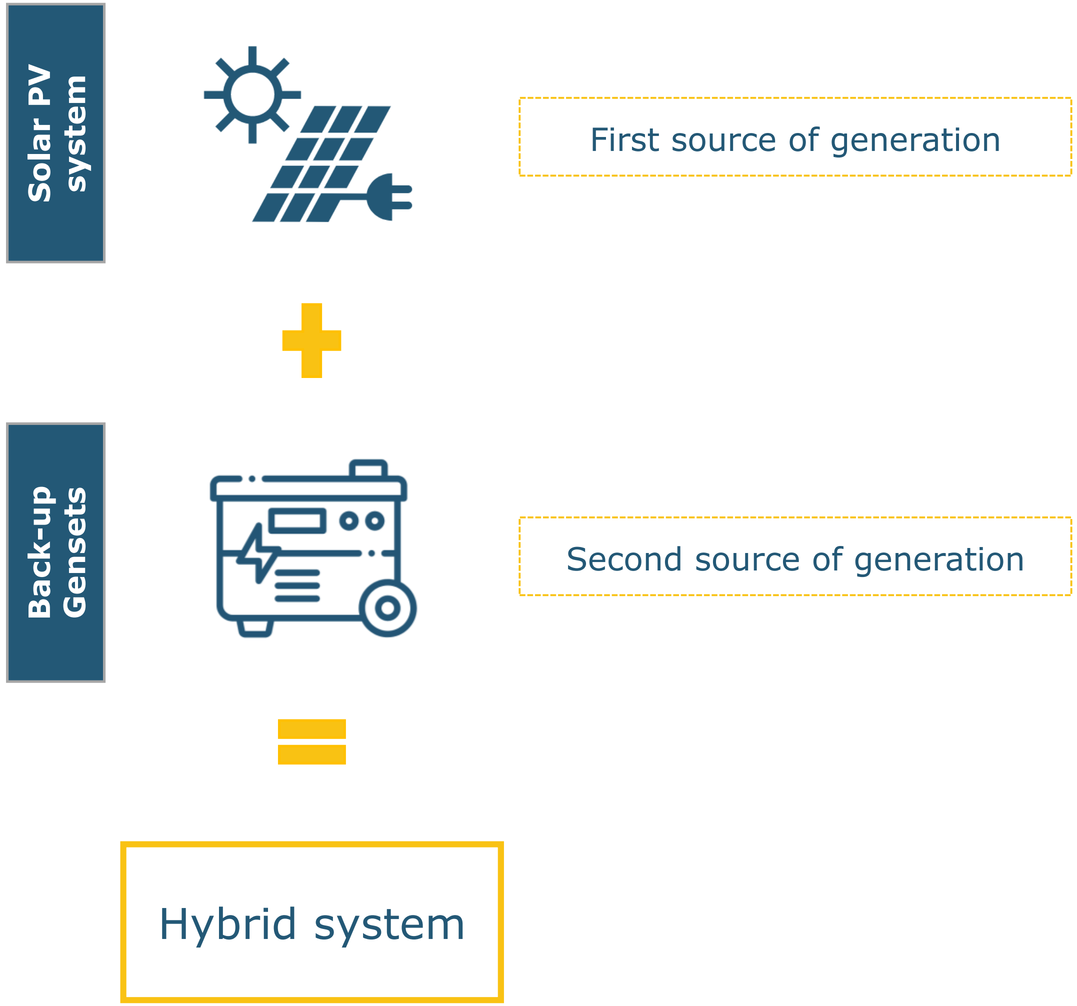
Tool 4 | Best Available Technology (BAT) for solar PV captive systems

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

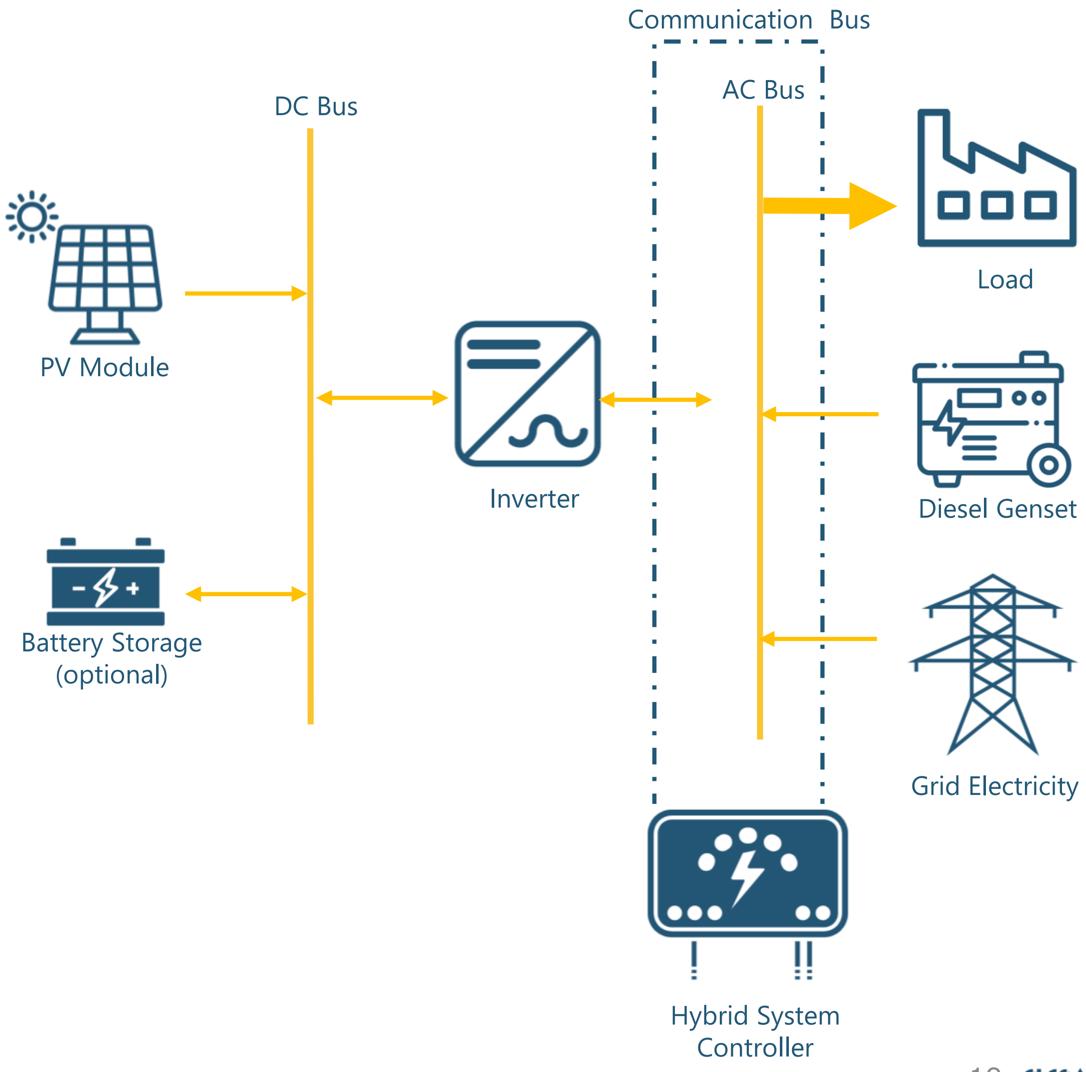


Tool 4 | Best Available Technology (BAT) for solar PV captive systems

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

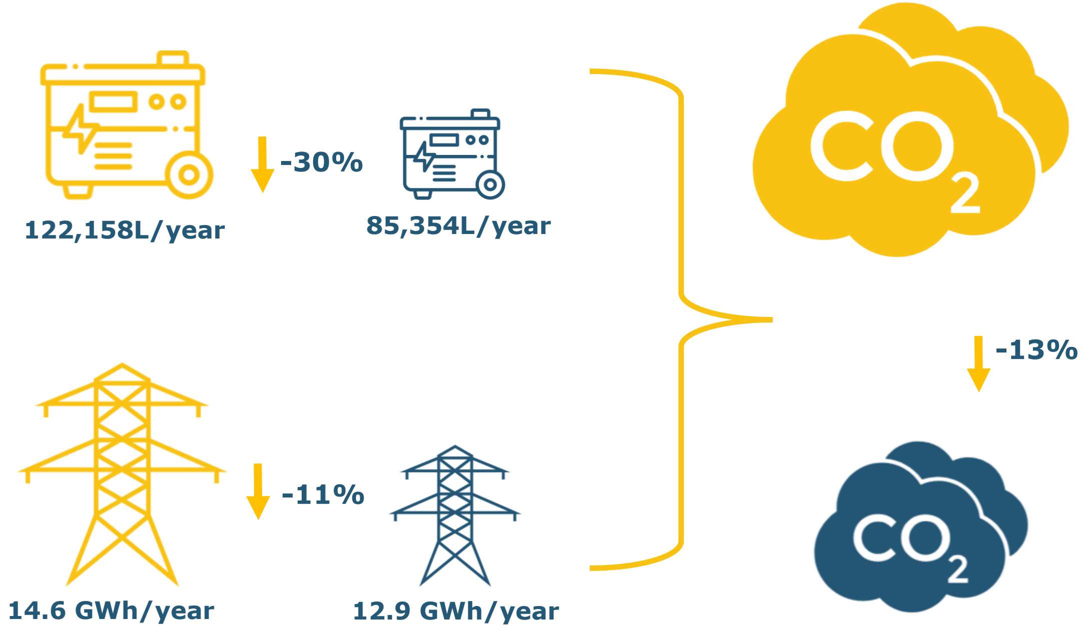
The Hybrid system

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

- Fuel savings
- Grid purchases savings
- Reliability of power supply
- Reduction in CO_2 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

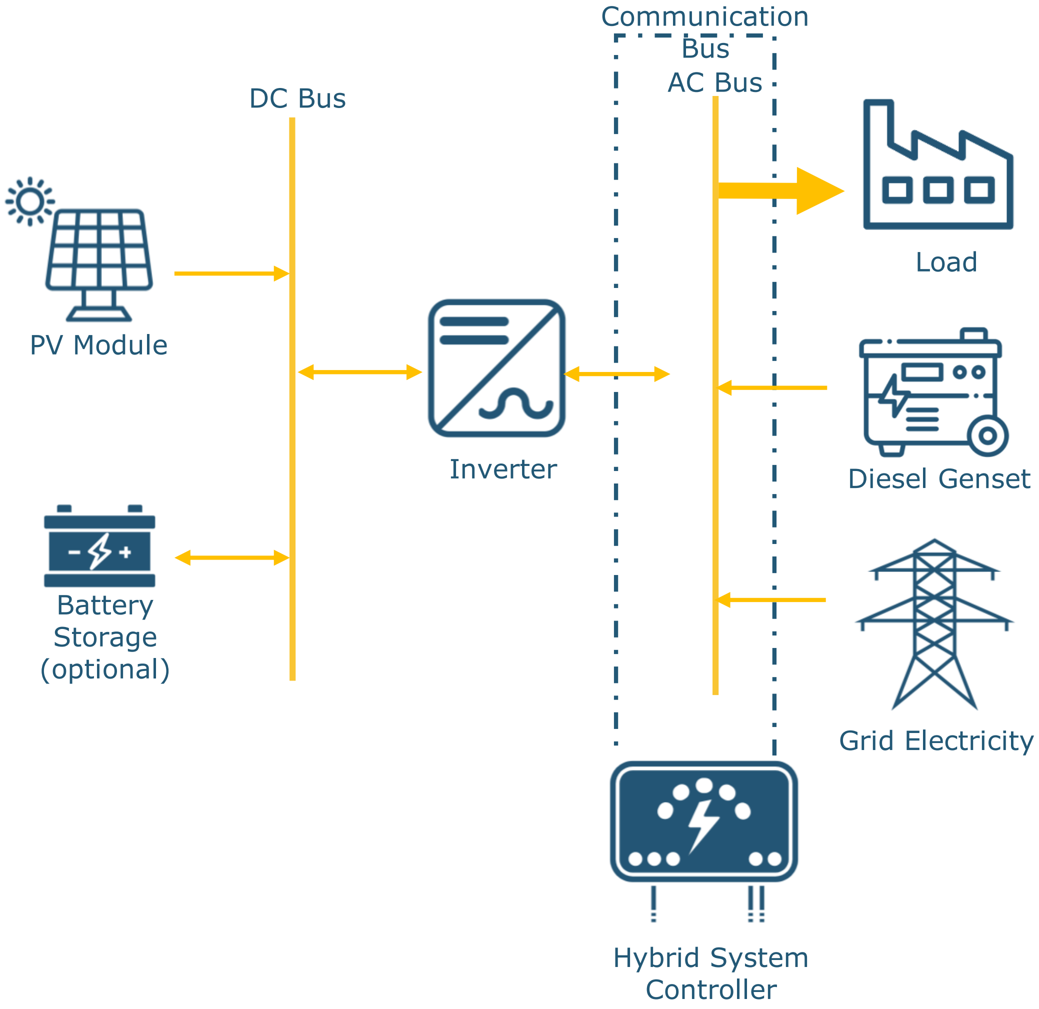
- Energy management system
- Ensure compatibility with Gensets and inverters

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

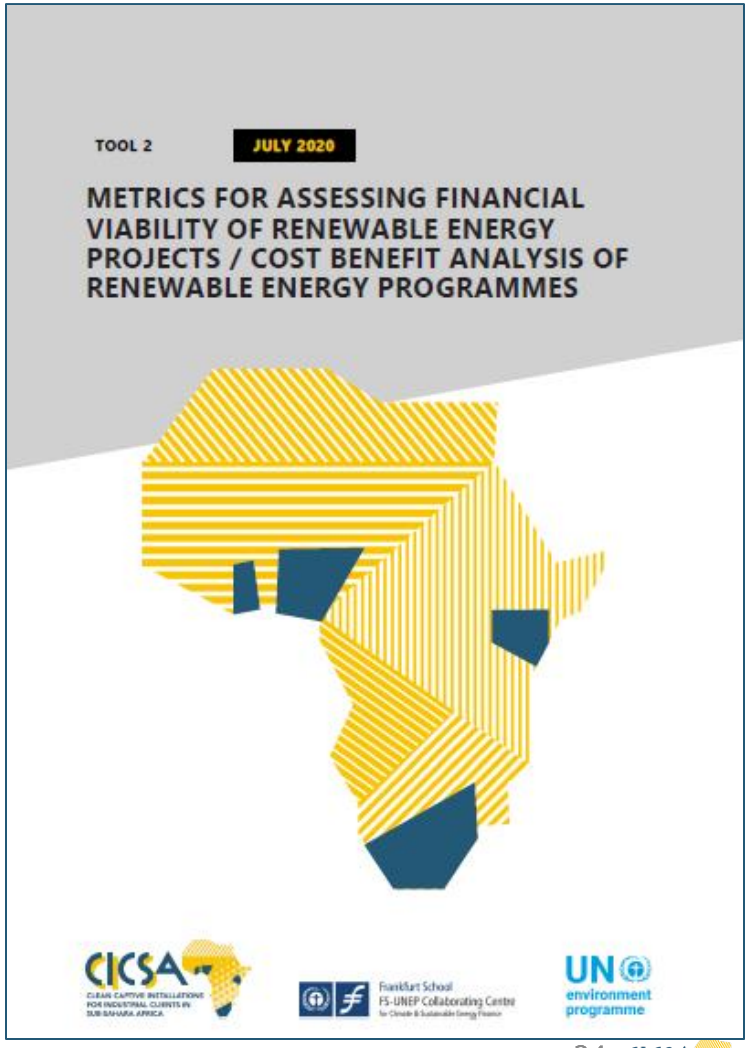
Content of the Tool

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

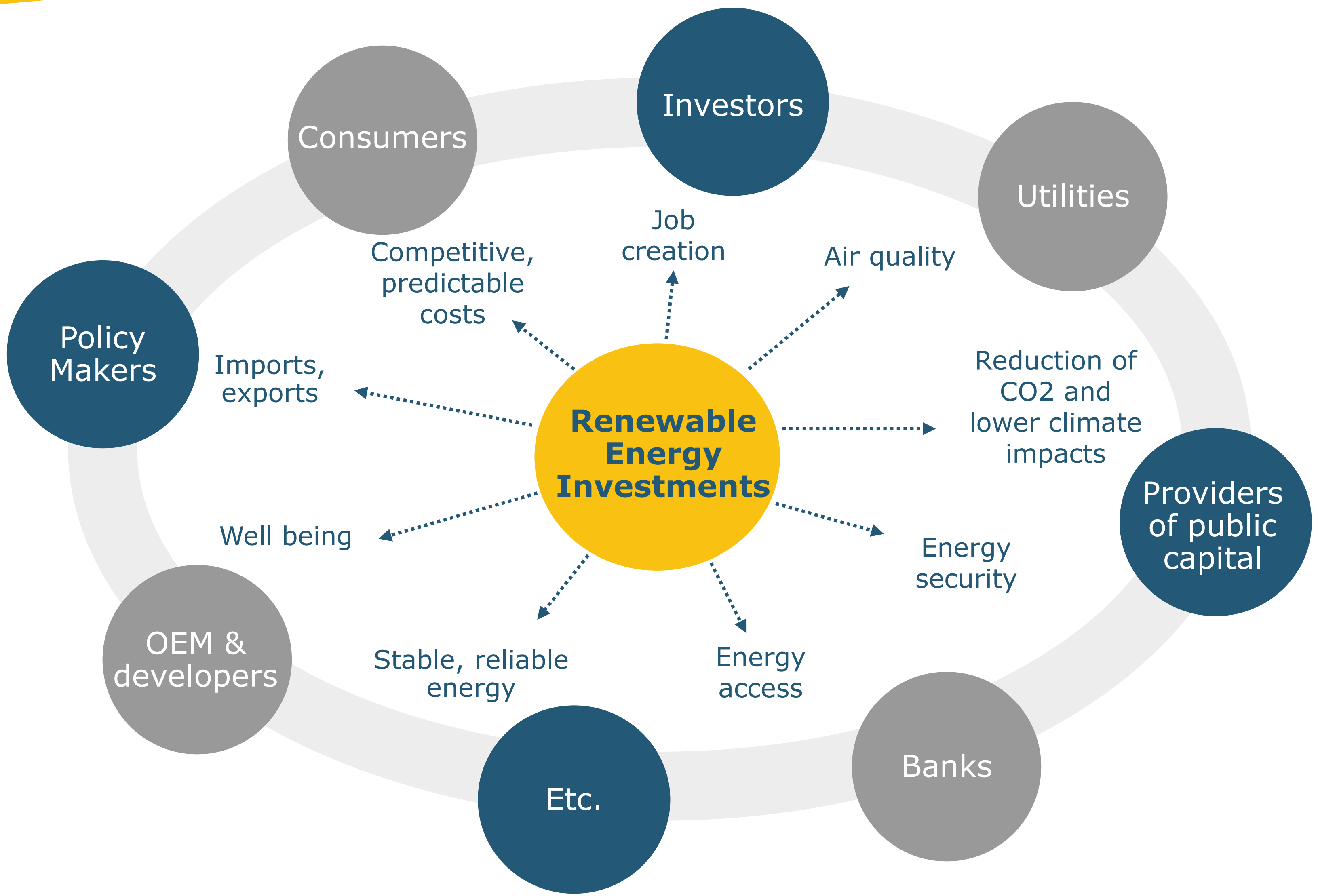
Analysis from various perspectives

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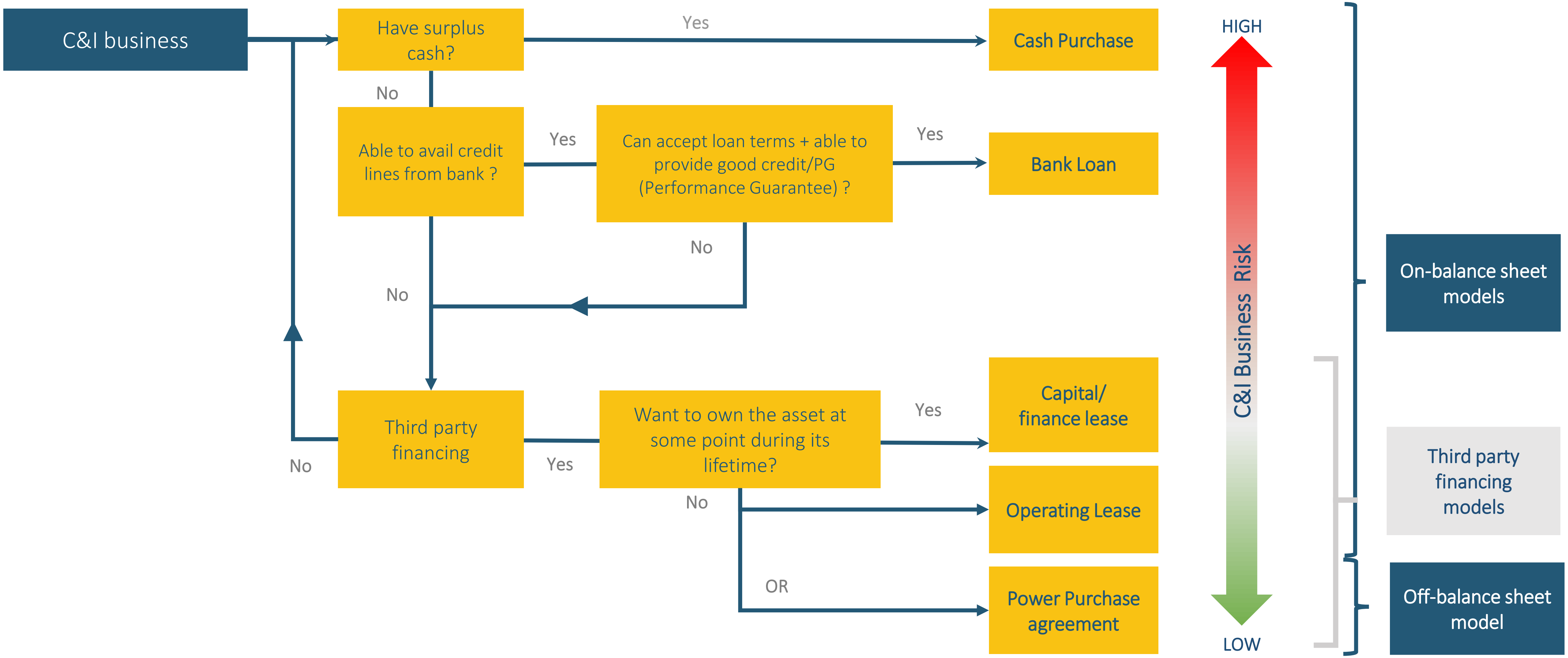
Tool 1 | Financing guidelines & business models for solar PV captive systems

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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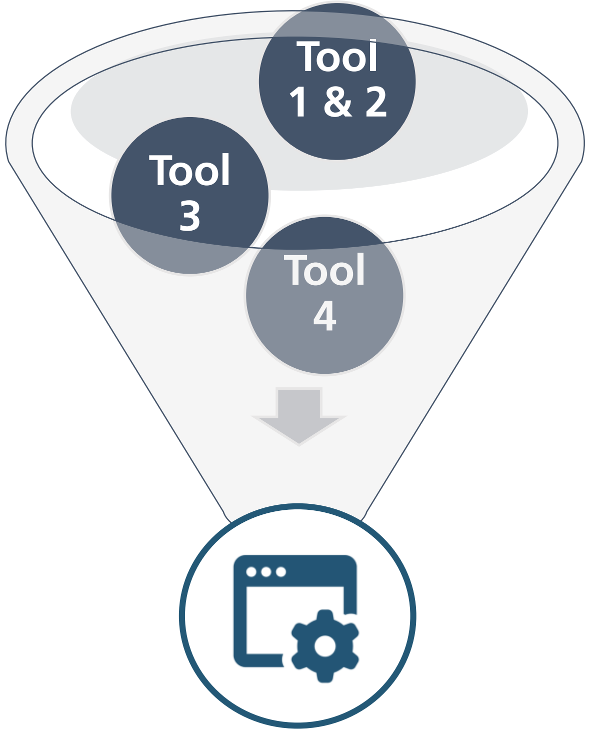

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Thank you for your patience!

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