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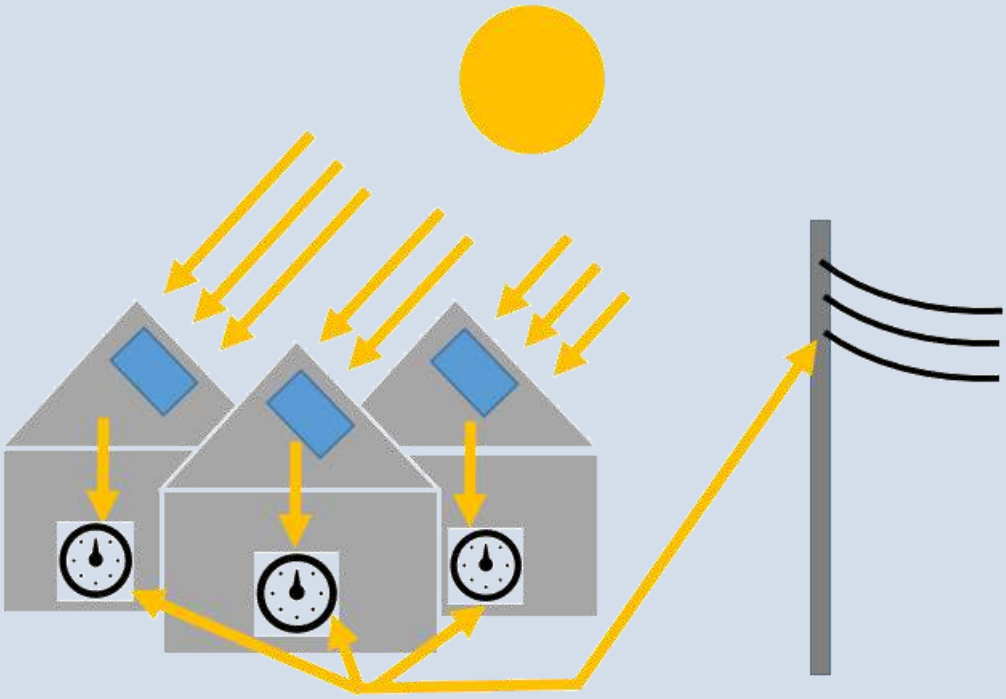
Net metering and PV self-consumption in emerging countries



PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Report IEA-PVPS T9-18:2018

INTERNATIONAL ENERGY AGENCY
PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Net metering and PV self-consumption in emerging countries

"Net metering" is a mechanism in which a self-generating customer can inject the surplus into the grid and receives, for each kWh injected, a compensation on his/her electricity bill

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Note:
Note: At the time of publishing, we are informed that Cabo Verde amended the decree on net metering on 15.10.2018. Analysis in chapters 2.7 and 3 may therefore be out of date.

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Contents

Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD) that carries out a comprehensive programme of energy co-operation among its 29 members. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

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Abstract

In 2013, PVPS Task 1 published a comparison of policies governing PV residential self-consumption in OECD countries. Following this report, it was decided to launch a second study, taking up the theme of PV self-consumption but focusing on so-called emerging and developing countries.

This study is limited to the "net metering" mechanism in which a self-generating customer can inject the surplus into the grid and receives compensation for each kWh injected.

From data collection done in a selection of countries and literature review, an inventory of best practices was made. Most important results are the 3 following points:

① In-depth analyses are necessary prior to setting up any compensation schemes.
② Strong political will and a user-friendly registration procedure are necessary to turn a law into concrete achievements.
③ It seems that net metering development in emerging countries can be split into two phases (i) First phase where net metering is mainly aimed at those whose investment capacities are relatively high (e.g. commercial users rather than residential ones) and (ii) second phase where net metering becomes interesting for all types of users since solar costs decrease.

Executive Summary

This paper is a comparative study in a number of African (Cape Verde, Burkina Faso, Benin, South-Africa, Kenya, Ghana) as well as Asian countries (India and Philippines) to review and analyse their respective PV self-consumption policies. Though PV **self-consumption policies** may be many and varied, this study only focuses on **net metering**, that "allows residential and commercial customers who generate their own electricity to feed electricity they do not use back into the grid" (Solar Energy Industries Association). Net metering prosumers (e.g. clients who are both *pro*ducer and con*sumer*) get a compensation for excess electricity that is exported to the grid. The level of compensation varies by location depending on the national or subnational net metering policies in place.

Eight countries were selected for the study. Having a sample group of countries is a mean to highlight challenges and opportunities regarding net metering in various contexts (e.g. insular context for Cape Verde and Philippines, extended experience in solar energy in India, etc.).
Moreover, this selection encompasses both, countries where net metering laws run smoothly (Philippines, India), and countries where net metering is allowed although no national framework is set yet (South Africa). This selection also focuses on countries where net metering is not yet in place: either because the law has not yet been implemented (Cape Verde, Kenya) or because net metering is not the core of current energy policy concerns (Benin).

Data collection conducted in this selection of eight countries resulted in datasheets (one per country). Datasheets present an overview of both electric sector status and net metering policies thanks to a set of indicators. Moreover, through literature review and interviews/discussions with key actors (researchers, policy makers); an inventory of net metering best practices was made.

Most important results are the 3 following points:

① In-depth analyses are necessary prior to setting up any compensation scheme. On the one hand, the distribution companies' fear of revenue losses has to be taken into account otherwise they might be reluctant to support and promote net metering. On the other hand, compensation schemes should be attractive enough to promote net metering amongst clients whose investment capacities are limited. Still the most important criterion to decide on the introduction of net-metering should be a scenario calculation based on realistic assumptions, to get an idea on whether net metering leads to (financial) losses or gains. If electricity is anyway sold at a subsidized tariff or electricity bills are not paid by specific consumer groups (e.g. governmental institutions), net-metering can definitely bring advantages by reducing ongoing losses.

② Strong political will is necessary to turn the law into concrete achievements. If the cost of fossil fuels is the sole motivation of governments, then the political will fluctuates. Instead, an actual ambition to increase the share of renewable energy sources and the quality / resilience of the electrical service is a key to successful implementation of net-metering. Moreover, a strong political will is necessary to set up an efficient and user-friendly registration procedure for people willing to join the net metering programme.

③ It seems that net metering development in emerging countries can be split into two phases (i) First phase where net metering is mainly addressed to those whose investment capacities are relatively high (e.g. industrial and commercial users rather than residential ones) and (ii) second phase where net metering becomes interesting to every type of user since solar costs decrease.

1. Introduction

1.1. Objectives

The objectives of this study are:

- Providing stakeholders with information,
- Sharing good practices,
- Stimulating exchange and cooperation between actors from different countries.

1.2. Scope of the study

This study aims at highlighting the opportunities arising from increasing urbanization: issues related to urban and peri-urban areas are the core of the study.
The study is limited to power generation systems below 1MW in order to focus on the residential sector though other actors (commercial, industrial) are not excluded.
The study focuses on regulatory, fiscal and economic issues; the technical aspects will not be taken into consideration.
The study concerns a single non-tax incentive mechanism (net metering) and its application to photovoltaic technology only.

1.3. About this report

A word of warning: The information contained in this publication is derived from carefully selected sources which we believe are trustworthy. We do not guarantee its accuracy or completeness and nothing in this document shall be construed as such a guarantee. Nothing herein shall constitute or be construed as an offering of financial instruments, or as investment advice or recommendation whether or not to implement net metering policy in a given context.

In this report, n/a means no relevant information has been found.

Currency is USD providing the following exchange rate (May 2018):

USD	Other currency
1 USD	0,83673606 EUR
1 USD	549.66 FCFA
1 USD	67.35949 INR
1 USD	51.89 PHP
1 USD	13.5135 ZAR

1.4. What is net metering?

Net metering is a type of contract that binds a self-generating customer and his energy distributor. In this contract, the customer is both a consumer and producer of electricity (for example, he/she has a rooftop solar power plant). The customer consumes electricity in real time (no storage) and surplus electricity is injected into the grid. For each injected kWh, the consumer gets compensation in the form of a credit: on his monthly bill, the customer can deduct the value of the kWh injected the previous months (within a time limit of generally one year). The customer also benefits from a reduced electricity bill through self-consumption of the electricity he or she produces that is consumed on-site.

In short, net-metering is a non-tax incentive for self-consumption of energy. The 3 types of non-tax incentives are explained below:

Non-tax incentives for self-consumption + partial injection

Feed-In-Tariff	**Green Certificate**	**Net metering / Net billing**
1 contract for electricity purchases **1 contract** for electricity sales	1 contract for electricity purchases **0 contract** for electricity sales	**1 single contract** for both electricity purchases and sales
For each kWh injected, the customer is paid according to the current feed-in tariff, regardless of the electricity bill that he may have	The customer *can* sell the green certificates he acquires when he injects renewable energy into the grid	On his month *n* bill, the customer can deduct the value of the month *n-1* injected kWh

2. Today's net metering situation

2.1. Overview

Net metering was born in Minnesota in the United States in 1983 (NREL[1]). The development of net-metering policies has been explosive since the 2000s. In most cases, net-metering applies at country level and is associated with other incentive mechanisms.
In its 2018 global status report, the REN21 publishes the list of countries that have implemented net metering.

High Income Countries	Upper Middle Income Countries	Lower Middle Income Countries	Low Income Countries
Australia	Albania	Armenia	Senegal
Bahrein	Argentina	Bolivia	Tanzania
Barbados	Brazil	Cape Verde	
Belgium	Costa Rica	Egypt	
Canada	Republic Dominican	Ghana	
Chile	Gabon	Guatemala	
Cyprus	Grenada	Honduras	
Denmark	Jamaica	India	
Greece	Lebanon	Jordan	
Israel	Mauritius	Kenya	
Italy	Mexico	Lesotho	
Korea	Panama	Micronesia	
Latvia	Peru	Moldova	
Lithuania	St Lucia	Morocco	
Malta	St Vincent and the	Pakistan	
Netherlands	Grenadines	Palestine	
New Zealand	Suriname	Philippines	
Saudi Arabia		Sri Lanka	
Singapore		Syria	
Slovenia		Ukraine	
United Arab Emirates		Vietnam	
USA			
Uruguay			

Source : http://www.ren21.net/wp-content/uploads/2018/06/17-8652_GSR2018_FullReport_web_final_.pdf

Why is net-metering particularly suitable for so-called emerging countries?
Solar potential is generally higher in emerging countries than in so-called "northern" countries. Most emerging countries are unable to meet the demand because of insufficient generation capacities in particular during peak hours (!). It is then necessary to either import energy or limit the energy service (shortage/blackout). Net metering allows both, to reduce the demand and to strengthen the generation capacity without major investment by the national company or IPPs.
Finally, the decline in solar equipment costs (in particular the panels) makes PV technology increasingly accessible even in countries where investment capacity is limited.
However, implementing net metering is not that easy. To avoid major difficulties, it is necessary (i) to properly assess the market (in order to define an appropriate regulation) and (ii) to set up the means / political will necessary to enforce this regulation.

2.2. Countries covered by the study

The study focuses on South Africa, Benin, Burkina Faso, Cape Verde, Ghana, Kenya, India and the Philippines.
This selection was chosen based on:

(i) the availability of data,
(ii) the state of maturity of regulation concerning net metering. Three categories can be differentiated:

Net metering **applies**	Countries where a regulatory framework exists but **no net metering applications for now***	Countries where net metering **is not allowed**
India The Philippines South Africa	Kenya Cabo Verde Ghana	Benin Burkina Faso

* Because e.g. the decree in not in force yet

This report focuses on each of the above countries individually before conducting a comparative analysis.

2.3. Focus on South Africa

Electricity sector status

In South Africa, generation and transmission of electricity are provided by Eskom, the national utility, which produces more than 95% of the energy (IRENA[2], 2013). South Africa has a semi-decentralized system with around 180 distribution companies that are either the municipalities or the Eskom National Society. The residential sector represents a demand of 16 GW (Solar Plaza, 2017). The energy mix is dominated by fossil fuels.

About net metering

In 2007, the demand for electricity was higher than the installed generation capacity. The national company Eskom was forced to organize power outages to protect network stability. As electricity tariffs increased, many people turned to alternative sources of energy (including solar), sometimes deployed without the necessary authorizations. Distribution entities (e.g. municipalities) had to fight against the development of unauthorized systems - which would have led to network management problems. And thus, the municipality of Nelson Mandela Bay (NMBM), as a pioneer, decided to engage in net metering. This choice was also motivated by the desire to increase production capacity and the share of renewable energy in the energy mix. In 2008, NMBM obtained regulatory approval (NERSA) to begin a pilot study of residential sites, which turned out to be conclusive (technical and financial viability). The feedback from NMBM led to the development of a technical guide named "Standard Conditions for Embedded Generation within Municipal Boundaries" compiled by NERSA in 2011. The first system under net metering was installed in March 2013. Since then, net metering is applied in some municipalities (34 of 164 municipalities in October 2017). Each municipality (or other distributors like Eskom), in agreement with the regulator, is free to authorize net metering or not and to propose specific types of compensation.

2 https://www.irena.org/documentdownloads/publications/irena_renewable_energy_auctions_in_developing_countries.pdf page 37

Distribution entity	Retail price (2015)	Compensation value (2015)
e Thekwini	0.08USD/kWh (excl.VAT)	0.05USD/kWh (i.e. 65% of retail price)
Nelson Mandela Bay	from 0.06 to 0.12USD/kWh (incl.VAT)	equal to retail price + service charge*

*Only clients over 950kWh/month are requested to pay 24USD/month as service charge

Source: ICLEI Embedded Energy Generation Experience Study Case 174 http://www.cityenergy.org.za/uploads/resource_317.pdf

No national regulatory framework has been established (a project is underway). On the other hand, document templates[3] have been drafted to facilitate the implementation of net metering (e.g. tariff model[4] developed with support of GIZ / SEA). The technical limitations the municipalities have to adhere to come from the following texts: RSA grid code, NRS 097-2-1, NRS097-2-3, Eskom grid interconnection standards. Finally, there are associations like PV Green Card (https://www.pvgreencard.co.za/) or SAPVIA (http://www.sapvia.co.za/) which act to improve the quality of the installations and the user information.

Lessons learnt

Value of excess energy: Municipalities receive no incentive to set up net metering and are free to choose the amount of compensation for energy injected (with the regulator's approval).
In the NMBM the compensation scheme (1: 1[5]) does not reflect the actual cost of embedded generation, since grid maintenance and upgrade as well as administrative cost are not included. Consequently, tariffs are supposed to be revised after an evaluation period.
Impacts on the end consumer: The majority of residential and commercial players expect payback periods of around 3 years while - in reality - a system is amortised after 7 to 12 years only (2015 analysis of payback periods based on savings on electricity purchases).
While some municipalities charge prosumers more than traditional customers, some municipalities put in place incentives to encourage customers to become producers / consumers. NMB municipality, for instance, has set up a tax incentive for businesses, which allows organizations to depreciate renewable energy assets over three years (year 1: 50%, year 2: 30%, year 3: 20%).
Impact on entities in charge of distribution: Municipalities are not solely responsible for the electricity distribution. The sale of electricity is not their main source of revenue. There is therefore no concern in South Africa as to shortfalls like other countries face with net metering. On the other hand, municipalities' motivation is not only financial, hence they are better accepted than private distribution companies. The NMBM experience confirms that net metering implementation requires resources: Staff must be allocated time and must be trained.

Mirror analysis from IEA Task 1 assignment (2016)

Completing a summary table is irrelevant because there is no single national regulation but rather as many regulations as municipalities.

For further information

➔ South Africa datasheet (see Datasheet section)
➔ Lessons learnt datasheet regarding Nelson Mandela Bay's Municipality (ICLEI Case Studies 174). Online http://e-lib.iclei.org/wp-content/uploads/2016/05/ICLEI_cs_174_NMBM_UrbanLEDS_2014-web.pdf

[3] i.e. A registration form : http://www.cityenergy.org.za/uploads/resource_412.pdf
[4] Model available online: http://www.cityenergy.org.za/getfile.php?id=437&category=5 and guidelines : http://www.cityenergy.org.za/uploads/resource_436.pdf
[5] 1:1 means that the client received 1kWh credit for each kWh he/she have injected on the grid

➔ Analysis from Solar Plaza: page 82 of Fact & Figures 2017 Report : https://www.solarplaza.com/channels/markets/11717/facts-figures-solar-energy-africa-2017/
➔ Status of Small Scale Embedded Generation In South African municipalities - October 2017 published by South African Local Government Association (SALGA) http://www.salga.org.za/SALGA%20Energy%20Summit%202018/Energy%20Summit%20Web/Document/Status%20of%20Small%20Scale%20Embedded%20Generation.pdf
➔ Consultancy document, published in 2015 : http://www.nersa.org.za/Admin/Document/Editor/file/Electricity/Consultation%20Paper%20Small%20Scale%20Embedded%20Gx.pdf
➔This website http://www.cityenergy.org.za/index.php

2.4. Focus on Benin

Electricity sector status

Benin is associated with Togo, its neighbouring country. Indeed, the import and export of electricity for these two countries is the responsibility of one single entity, the Benin Electric Community (CEB) which operates on behalf of these two countries. The average sales price (0.13 USD[6] / kWh in 2016) is higher than the average production cost (0.11 USD / kWh) but the annual result is negative and deteriorating since 2014. Benin-Togo imports 6 times more electricity than both countries produce[7] and their production is based on hydro and thermal plants.

About net metering

Despite the above-mentioned factors which are conducive to the implementation of net metering, Benin does not seem ready to put in place a regulatory framework for net-metering. Indeed, Benin currently has no experience in regulating power injection into the network: it is in the process of setting up a feed-in tariff, which seems to be a priority before considering net metering. In fact, a framework for RE self-consumption, for both on-grid and off-grid installations is about to be set up, with the support of ECREEE and GIZ. The following decree will be adopted as soon as the law will come into force: “Promotion de l’autoproduction et de l’autoconsommation de l’électricité à base d’énergies renouvelables avec ou sans injection sur le réseau“(Promotion of electric self-consumption from RE with or without grid injection).
As Togo and Benin have common electricity import/export management, net metering implementation in Benin would probably require overall thoughts at the level of both countries.

For further information

➔ Benin datasheet
➔ The Utility (SBEE) website: https://www.sbee.bj/
➔ Benin Electric Community website: http://www.cebnet.org/

2.5. Focus on Burkina Faso

Electricity sector status

Regarding electricity, Burkina-Faso has one main network (called segment 1) which carries 91% of the total energy and is under the responsibility of SONABEL, the national operator. The remaining 9% is named segment 2 and managed by COOPELs (ELectrical COOPerative). The average cost is higher than the average retail tariff which leads to a negative net income for SONABEL

[6] source : CEB. http://www.cebnet.org/ceb-en-bref/chiffres-cles
[7] Source 2016 annual activity report of SBEE (national Utility)

(17,000,000 USD deficit in 2015). 36% of the energy produced is imported, mainly from Côte d'Ivoire, Ghana and Togo.[8]

About net metering

Despite the dependence on imports and the fact that current production capacities are not sufficient to meet electrical demand, net metering is not yet a priority on the agenda. Indeed, Burkina Faso is currently setting up a regulatory framework for the purchase of electricity from IPPs, for which the country benefited from a Technical Assistance under SE4ALL. Setting up a regulatory framework for the purchase of electricity from IPPs seems to be a priority before considering other regulatory frameworks like e.g. on net-metering for prosumers.

For further information

➔ Burkina-Faso's datasheet (see Datasheet section)
➔ Report "Assistance à la mise en place des conditions technico-économiques pour le soutien au développement de la filière photovoltaïque raccordée au réseau", SE4ALL, 2017

2.6. Focus on Kenya

Electricity sector status

Kenya's electricity sector consists of a main network and mini-grids. Electricity generation is mainly based on renewable energy with 40% hydro and 49% geothermal energy[9]. Import dependence is very low (1.7% of production, mainly imported from Uganda).

About net metering

Following technical assistance from international cooperation (GIZ and others), Kenya is in the process of putting in place a regulatory framework for net metering (see 2015 Energy Bill); its content is still under discussion. A feed-in tariff is in place since 2012, but registration procedures are complex. Currently, despite a tariff exemption for solar panel imports, and a feed-in tariff 0.12 USD / kWh no dramatic achievement has been reached. Similar difficulties may arise with net metering if no investment subsidy is set up to help individuals invest in solar installations.

For further information

➔ Kenya datasheet
➔ Solar Plaza's analysis: page 53 Fact & Figures 2017 report (financial data) :
https://www.solarplaza.com/channels/markets/11717/facts-figures-solar-energy-africa-2017/
➔ German Cooperation (GIZ) analysis: EUEI-PDF Kenya 2013 Project Renewable Energy Regulator Capacity Development – Assessment of a net metering program in Kenya. Volume 1 Main Report. March 2014 pp3-5. March 2014

2.7. Focus on Cabo Verde

Electricity sector status

Cape Verde is a country composed of 10 small islands and 13 islets, located in the Atlantic Ocean. It has few natural resources. In 2012, the retail price of electricity for the residential consumer was of 0.45 USD / kWh, which is one of the most expensive in sub-Saharan Africa (IRENA). However, this high tariff does not even cover the costs because production is expensive (82.7% of the energy comes from thermal power plants – imported fuel or diesel) and the level of losses is

[8] Source ARSE - 2014 activity report
[9] KPLC annual report 2016/2017 page 44

high (25% in 2007[10]). According to the Energy Director, the share of renewable energy in the energy mix is of 17.3% in 2017, which represents a slight decrease compared to the previous years.

About net metering

To improve the electricity situation, Cape Verde has drawn up an ambitious action plan in order to reach the target of 50% renewable energy share in the energy mix by 2020. A decree published in 2011 allows net metering, under the name of 'Microgeneration Regime', for renewable generation up to 100 kW. This law was however never implemented. Despite GIZ's assistance to Cape Verde on net metering policies design, it seems that the implementation remains tedious because (i) the tariff is not in favour of the national company (ELECTRA) and (ii) the size limit (<100kW) of the systems is low.

Lessons learnt

Value of excess energy: The client gets one kWh for every kWh he injects to the grid.
Impacts on the end consumer: No impact because the law is not yet implemented.
Impact on entities in charge of distribution: It seems that ELECTRA is afraid of revenue losses due to both self-consumption and revenue losses resulting from compensation.

Mirror analysis of Task 1 assignment (2016)

CAPE VERDE			
PV self-consumption	1	Right to self-consume	Yes
	2	Revenue from self-consumed PV	Yes (saving)
	3	Charge to finance T&D	n/a
Electricity excess	4	Revenues from excess electricity	n/a
	5	Maximum timeframe for compensation	n/a
	6	Geographical compensation	No
Other characteristics	7	Regulatory scheme duration	Undetermined
	8	Third party ownership accepted	No
	9	Grid code	Law Decree nº1/2011
	10	Other enabler of self-consumption	No
	11	PV System Size limitation	100kW
	12	Electricity System Limitations	n/a
	13	Additional features	n/a

For further information

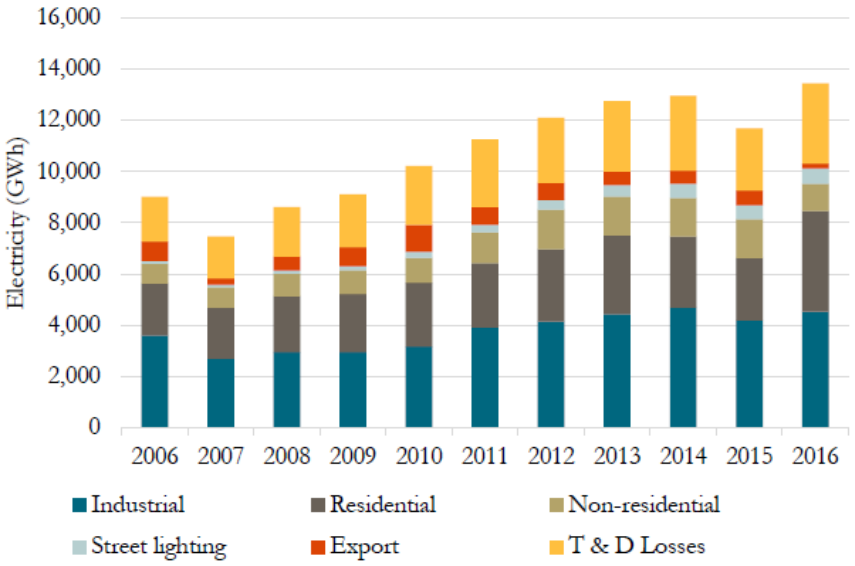
➔ Cape Verde datasheet (see Datasheet section)
➔ The law dealing with microgeneration regime
Law Decree nº1/2011 (up-dated in Jan. 2014): Incentive Regime for Renewable Energy Promotion

2.8. Focus on Ghana

Electricity sector status

Peak demand increased by 50% between 2006 (1 393 MW) and 2016 (2 087 MW). Production capacity has increased in the same proportion over this period, but the country still faces power cuts. The graph below shows that industry and the residential sector electricity consumption accounts for more than half of the energy generated in Ghana.

[10] Source : https://expressodasilhas.cv/economia/2018/02/25/perdas-totais-na-distribuicao-causam-prejuizos-de-27-milhoes-de-contos/56791



Source: Ebenezer Nyarko Kumi. 2017. "The Electricity Situation in Ghana: Challenges and Opportunities." CGD Policy Paper. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/electricity-situation-ghana-challenges-and-opportunities

Transmission of electricity is taken care of by GRIDCo, a national company, while distribution is the responsibility of both of the following companies: Electricity Company of Ghana (ECG) and Northern Electricity Distribution Company of Ghana (NEDCo). A map of the national interconnected transmission system of Ghana is available on: http://www.gridcogh.com/en/national-grid.php

About net metering

A law was put in force in 2015 to regulate net metering for plants under 200 kW. According to this law, each kWh exported to the grid entitles to a compensation of one kWh, fully supported by the distribution companies (i.e. no incentives are given by government or other entities). The cost of the bidirectional meter will be charged to the customer. A pilot study was supposed to be conducted before the actual implementation of the net metering scheme. This pilot study was prepared under the responsibility of the regulators (PURC and EC) and the Ministry of Energy. It is still ongoing and no results are available for now. In 2016, a program to encourage solar self-consumption was launched consisting in either the coverage of the investment for solar panels, or the direct provision of panels. This program includes installations up to 500 kWp (therefore larger than those for which net metering is allowed, that is up to 200 kWp). The initial objective was the connection of 20,000 solar rooftop systems. The following conditions must be met to obtain this help:

1. Change all lamps in their facility to LED lamps;
2. Be willing to purchase BoS Components;
3. Installation of the BoS is to be done before the supply /installation of the Program's PV panels;
4. Install only deep cycle batteries designed for solar PV systems;
5. Ensure that BoS meets the minimum Standards set by Ghana Standards Authority (GSA); and
6. Use only solar PV installers licensed by the Energy Commission for all the installation works.

While several projects have already benefited from the Solar Rooftop Program, net metering has not yet produced concrete results despite the fact that all the framework seems to be in place. When the net metering is in place, it will be possible to benefit from both the Program's subsidy and the net metering compensation scheme.

Lessons learnt

There are no concrete achievements with regard to net metering for now. Reducing delays between the implementation of the law and effective enforcement requires strong political will and instruments for monitoring.

In the frame of NSRP, some information is available online, such as a list of partner banks and a list of 80 solar vendors. This is a very good point for end-user's information. Unfortunately, this data is not up to date as per February 2018.

Mirror analysis of IEA Task 1 assignment (2016)

GHANA			
PV self-consumption	1	Right to self-consume	Yes
	2	Revenue from self-consumed PV	Yes (saving)
	3	Charge to finance T&D	n/a
Electricity excess	4	Revenues from excess electricity	Yes*
	5	Maximum timeframe for compensation	1 year[11]
	6	Geographical compensation	no
Other characteristics	7	Regulatory scheme duration	Undetermined**
	8	Third party ownership accepted	n/a
	9	Grid code	Net metering Subcode 2015
	10	Other enabler of self-consumption	National Rooftop Solar Programme (NSRP)
	11	PV System Size limitation	200kWp
	12	Electricity System Limitations	n/a
	13	Additional features	n/a

* The client received 1kWh credit for each kWh he/she have injected on the grid

** Can be terminated by the customer at any time. Can be terminated by the distribution company only if the customer does not comply with the regulations in force (source: Subcode 2015 - 40 and 41)

For further information

➔ Ghana's datasheet (see Datasheet section)

➔ Electricity sector information available in the following publication: Ebenezer Nyarko Kumi. 2017. "The Electricity Situation in Ghana: Challenges and Opportunities". CGD Policy Paper. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/electricity-situation-ghana-challenges-and-opportunities

➔ Solar Plaza's analysis : Fact & Figures 2017 report page 27 : https://www.solarplaza.com/channels/markets/11717/facts-figures-solar-energy-africa-2017/

➔ Net metering subcode: http://energycom.gov.gh/files/Net%20Metering%20Sub-Code%2C%202015.pdf

➔ Solar rooftop programme: http://rooftopsolar.energycom.gov.gh/about-nrp

➔ Additional info: http://151.80.133.24:90/gheatweb/Home/Project

2.9. Focus on India

Electricity sector status

India is the third largest producer and fourth largest consumer of electricity in the world, with an installed power capacity reaching 340 GW as per April 2018. Regulators exist both at country level

[11] After one-year, excess credits which a prosumer got and are not used during that year are lost. Excess credits which are not used within one year cannot be transferred into the next year, they are lost.

and (federal) States' level. Tariffs are set according to the national Tariff Policy (2006) that includes amendments to focus more on sustainable use of renewable energy resources. Although the energy mix is dominated by thermal sources (about 65%), the hydro share is about 13% and other renewable energies account for about 20% in the total mix.
India has ambitious targets regarding PV generation, aiming at reaching 100 GW by 2022, among which 40 GW should be from rooftop solar plants. To achieve these, several incentives apply as detailed below. Besides, energy purchase obligations have been imposed on distribution companies that must justify a certain percentage of renewable energy ranging from 4% to 14% of their total generation (RPS, Renewable Energy Portfolio Standards). Moreover, India is preparing a "rent a roof" policy to boost solar rooftop development to enable developers to access roofs and become solar energy producers[12]. Power is one of the key sectors attracting Foreign Direct Investment inflows into India.

About net metering

Net metering as well as Feed-In-Tariff (also named gross metering) are available in India, with variations according to the States' regulations. "Third party ownership" is also allowed but is not considered as a net metering option. It is called "Open access". Below is an excerpt of a document published in the "Best Practice Guide – Implementation of State Level Solar Rooftop Photovoltaic Programme in India (page 19-20)" by Indian Renewable Energy Development Agency.

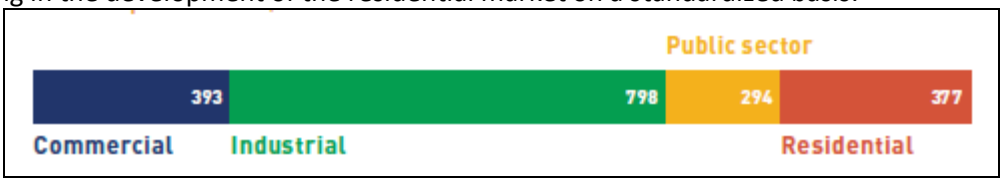
Parameter	Sales to Distribution Licensee		Sale to Third Party
	Net Metering	Feed-In Metering	Open Access
PV System Capacity	Limited to consumer's contract demand/sanctioned load	Limited by the available rooftop area (or related to associated distribution transformer capacity) or as per the relevant terms of RPS, if applicable.	Based on mutual agreement between developer and off-taker.
Ownership	Self-owned	Self-owned or third-party owned.	Third-party owned.
Billing Cycle	As per consumer's current billing cycle	Monthly	Solar energy to be adjusted on a 15 minutes-basis
Banking	Excess energy allowed to be banked during a financial year, at the end of which excess generation will be paid at an appropriate tariff determined by concerned SERC.	Not applicable as the energy is sold to the distribution licensee at the tariff determined by concerned SERC	No banking allowed for third party sale of power. Any excess, unadjusted energy shall be purchased by the distribution licensee at the tariff determined by concerned SERC
Tariff	As determined by SERC from time to time	As determined by SERC from time to time or based on competitive bidding using SERC's tariff as benchmark	Mutually agreed between developer and consumer
Electricity duty	Not applicable	Exempted	Exempted

[12] source: https://www.livemint.com/Industry/Y9LTkS5U96ZXgaQIiyYHTM/Govt-planning-rent-a-roof-policy-in-solar-power-push.html

Source : https://mnre.gov.in/file-manager/UserFiles/Best-Practices-Guide-on-State-Level-Solar-Rooftop-Photovoltaic-Programs.pdf

Limitations can apply both at transformer level (on a first come first served basis) and at a single system level (see appendix).

As per September 2017, the total solar rooftop installed capacity was of 1,861 MW. As can be seen from the breakdown per customer type in the graph below, Industry takes the lion's share, illustrating that project developers and EPC contractors need this larger unit sized market before engaging in the development of the residential market on a standardized basis:



Source: Bridge to India. India Solar Rooftop Map 2017. [online] http://www.bridgetoindia.com/reports/india-solar-map-september-2017/

Lessons learnt

Value of excess energy: depends on each State's regulation.

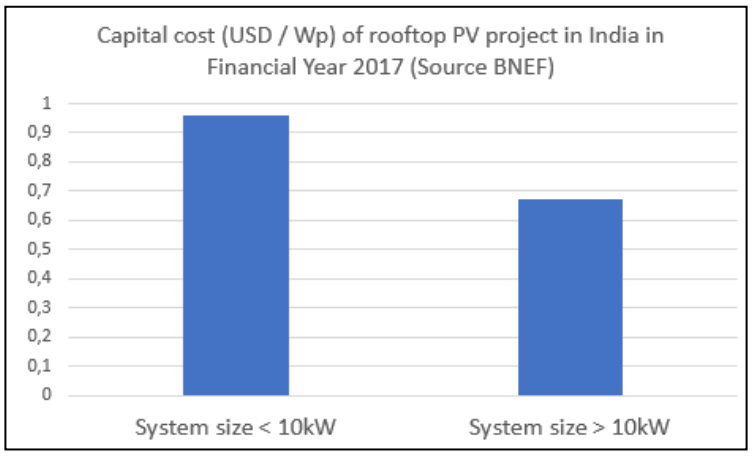
Impacts on the end consumer: For the time being, solar rooftop installed capacity reaches only 3% of 2022's target (40 GW) because residential development has been slower than expected. Solar rooftop mostly benefits to industrial and commercial end-users, because:

(i) Indian solar costs for residential users are 44% higher than commercial and industrial PV, mainly due to higher soft costs and absence of economies of scale.

(ii) Residential electricity retail price is 0.06-0.09 USD/kWh, while commercial retail price is about 0.09- 0.15 USD /kWh. Thus, commercial users are more interested in alternative energy sources than residential users are.

(iii) Administrative procedure for net metering registration are said to be long and tedious.

(iv) The range of products aimed at residential customers is very limited, because companies put their effort in the design of products targeting their most profitable clients, namely commercial and industrial clients who buy larger systems.



Source: "Accelerating India Clean Energy Transition - The future of rooftop PV and other distributed energy markets in India". [online] https://data.bloomberglp.com/professional/sites/10/BNEF_Accelerating-Indias-Clean-Energy-Transition_Nov-2017.pdf

Impact on entities in charge of distribution: n/a

Mirror analysis of IEA Task 1 assignment (2016)

Completing a summary table is irrelevant because there are no national regulations but as many cases as federal states.

For further information

➔ India datasheet (see Datasheet section)

➔ IBEF's analysis: https://www.ibef.org/industry/power-sector-india.aspx. Especially page 22 for a review of India power policy and page 27 for recent programme applying in India

➔ Bloomberg New Energy Finance's analysis 2017. "Accelerating India Clean Energy Transition - The future of rooftop PV and other distributed energy markets in India". [online] https://data.bloomberglp.com/professional/sites/10/BNEF_Accelerating-Indias-Clean-Energy-Transition_Nov-2017.pdf

➔ Bridge To India website and their Solar RoofTop Map : http://www.bridgetoindia.com/wp-content/uploads/2017/12/India-Solar-rooftop-Map-Dec.pdf [en ligne]

2.10. Focus on the Philippines

Electricity sector status

The Philippines have 3 main power grids and many mini grids. About twenty private companies and 119 electric cooperatives are in charge of distribution. Though the Philippines have hydro and geothermal resources, fossil fuels still dominate the energy mix. Since the coming into effect of the "Renewable Energy Act" (Republic Act 9513) in 2008, the distribution companies have to comply with a Renewable Portfolio Standard (RPS). RPS obligates distribution utilities to get 1% of their supply from RE as of 2019.

About net metering

Net metering is in place since the implementing rules were approved in 2013. Eligible renewable energy technologies include wind, solar, biomass or biogas or other RE systems that can be installed in the customers' premises. As of December 31st 2017, 1,329[13] customers are under net metering contracts. It represents an installed capacity of 9.5MW[14]. The development of net metering is slow because of (i) the administrative complexity to get a net metering agreement, and (ii) target customers' low investment capacity (i.e. residential and businesses). Indeed, future prosumers are asked to pay an impact[15] study (whose cost is set by the distribution company, i.e. 5000 PhP - 96 USD). Export of kWh is compensated on the basis of the average generation cost (average cost of supply of the Utility and its pool of power suppliers). Thus, the value of a credit can vary from one distribution company to another. In February 2018 for instance, for a customer consuming 100 kWh at the Manila Electric Company (MERALCO), credits are valued 0.09 USD / kWh while the selling price of MERALCO is 0.16 USD / kWh. To date, according to information from experts who assisted The Philippines on net metering topics, none of the implemented studies has shown any negative effects of net metering on distribution companies in the Philippines.

Lessons learnt

Value of excess energy: Exported kWh's are compensated on the basis of the average generation cost (average cost of supply of the Utility and its pool of power suppliers), which is for many potential net metering customers not an incentivising compensation level.

Impacts on the end consumer: Some net-metering consumers were able to reduce their monthly kWh consumption down to the level which entitles them to even receive subsidy (lifeline) which is originally intended for poor households.

Impact on entities in charge of distribution: It seems that some distribution companies were afraid of revenue losses (due to losses of sales). The main driver for Philippine companies is that net metering is seen as a means of compliance to the Renewable Portfolio Standard (RPS).

[13] National Electrification Administration, December 2017

[14] National Electrification Administration, December 2017

[15] (Technical) "Impact" on the network

Mirror analysis from IEA Task 1 assignment (2016)

PHILIPPINES			
PV Self-consumption	1	Right to self-consume	Yes
	2	Revenue from self-consumed PV	Yes (savings)
	3	Charge to pay to finance T&D	Yes (impact study)
Electricity excess	4	Revenues from excess electricity	Yes *
	5	Maximum timeframe for compensation	1 year[16]
	6	Geographical compensation	No
Other characteritics	7	Regulatory scheme duration	Undetermined
	8	Third party ownership accepted	No(1 pilot study**)
	9	Grid code	Grid code
	10	Other enabler of self-consumption	-
	11	PV System Size limitation	100kW
	12	Electricity System Limitations	n/a
	13	Additional features	Yes: Client has to be net importer[17] on yearly basis

* Compensation rate equal to average production cost.
**A NAMA project, still in the project preparation stage, is actually proposing a model for third party ownership

For further information

➔ An analysis by KPMG, global network of professional firms providing audit, tax and advisory services, with an industry focus. Published in 2015, available online. See page 52
https://assets.kpmg.com/content/dam/kpmg/pdf/2015/09/taxes-and-incentives-2015-web-v2.pdf

➔ Technical guides published by GIZ, including case studies and calculation of investment return time under different hypotheses
https://www.doe.gov.ph/sites/default/files/pdf/netmeter/net-metering-reference-guide-philippines-E.pdf

➔ The « Renewable Energy Act » (RA 9513)

➔ An analysis by Roberto Verzola, Executive Director, Centre for Renewable Energy Strategies. Philippine Pseudo-Net-Metering Scheme - Results In The Double-Charging Of Consumers. Published in 2016, available online.
https://rverzola.files.wordpress.com/2016/01/philippine-pseudo-net-metering-results-in-the-double-charging-of-customers-by-rverzola.pdf

2.11. Comparative analysis

The comparative analysis focuses on:
- The value of excess energy injected into the network
- Impacts on the final consumer and the PV sector
- Impacts on distribution companies.

Summary

	Cape Verde	Ghana	South Africa	India	Philippines
Scope of	National	National	Municipal	Individual	National

[16] After one-year, excess credits which a prosumer got and are not used during that year are lost. Excess credits which are not used within one year cannot be transferred into the next year, they are rather lost.
[17] Meaning that, on a yearly basis, the prosumer needs to consume more than he feeds into the grid

regulation				federal state	
System size limits	100 kW	200 kW	100 kW	*	100 kW

* The power limit varies according to the specific federal State, it ranges between 250 kW and 1 MW, according to The Solar Rooftop Map published by Bridge To India.

Uptake/Lack of uptake of net-metering programme

	Uptake	**Reasons for uptake** / Reasons for lack of uptake	Reasons for (absence of) implementation
South Africa	Net metering in 34 of 164 municipalities*	Municipalities are responsible for electric distribution. They are keen on increasing RE in the mix because of its positive impact on air quality.	**Net metering was implemented to** increase the generation capacity and to regulate illegal systems.
Benin	n/a	n/a	**Net metering is not the core of current energy policy concerns** as Benin currently focuses on implementing a framework for RE self-consumption
Burkina Faso	n/a	n/a	**Net metering is not the core of current energy policy concerns**: Burkina Faso is currently setting up a framework for feed-in-tariff
Kenya	No achievement yet	Political will is currently not sufficient to set up a juridical framework	n/a
Cabo Verde	No achievement yet	Political will is currently not sufficient to turn the law into concrete achievements	**Net metering was implemented to** increase RE in the mix and to reduce dependency on imports
Ghana	No achievement yet	Political will is currently not sufficient to turn the law into concrete achievements	n/a
India	3% of solar rooftop 2022's target is achieved***	Renewable Portfolio Standards that discoms** have to comply with	**Net metering was implemented to** boost solar rooftop development
Philippines	1,329[18] customers are under net metering contracts	Renewable Portfolio Standards that discoms** have to comply with	**Net metering was implemented to** increase RE in the mix and to reduce dependency on imports

* as per October 2017

** discom = distribution companies

*** these figures are not related to net metering but solar rooftop capacity target

[18] National Electrification Administration, December 2017

Value of energy surplus fed into the grid

	Cape Verde	Ghana	South Africa	India	Philippines
Regulation	Each injected kWh gives rise to a compensation of 1kWh	Each injected kWh gives rise to a compensation of 1kWh	Varies per Municipality	Varies per federal State	Exported kWh is compensated on the basis of the average generation cost (average cost of supply of the Utility and its pool of power suppliers)

Source: Regulations

Impacts on customers

Both savings resulting from self-consumption and from the excess energy fed to the grid will allow the user to depreciate his system over a shorter period of time provided (i) the initial investment is low and (ii) conditions of compensation are interesting. Thus, in case the PV generation cost for the individual is lower than the tariff of the utility, self-consumption is attractive.

	Cabo Verde	Ghana	South Africa	India	Philippines
Payback time	n/a	n/a	7 to 12 years (2015)	from 8.3 to 10.5 years	6-7 years (2013)
Sources	n/a	n/a	See below	See Case Study - India	See Case Study - Philippines

Source for South Africa: Embedded energy generation experience in a South African metropolitan municipality. [online] http://e-lib.iclei.org/wp-content/uploads/2016/05/ICLEI_cs_174_NMBM_UrbanLEDS_2014-web.pdf

Impacts on distribution companies

	Cabo Verde	Ghana	South Africa	India	Philippines
Distribution Companies' point of view.	The national company ELECTRA seems to fear unfavorable compensation scheme	No impact currently as no accredited system is in place	Distribution companies (= municipalities) negotiate the compensation scheme (with annual revisions) with the regulator	n/a	Although utilities don't pay more for prosumer compensation than their own generation cost, progress is slow and the Renewable Portfolio Standards had to be introduced (enforces 1% of RE).

Distribution companies fear a reduction of their profitability due to (i) self-consumption (i.e. sales reduction) (ii) energy compensation (revenue losses) and (iii) the necessary changes in invoice management (i.e. required capacity building of their staff).
Several means to reduce these risks exist: see the following items in Best practices' section:

- Adapt regulatory framework as the number of prosumers increases
- Optimize the compensation scheme (the value the customers get for each injected kWh)
- Only compensate the injected energy

2.13 Other countries

In 2011, the German International Cooperation GIZ published an analysis which – besides the experience with net-metering in Kenya – also provides international experience for the following countries: United States, Denmark, Brazil, Mexico, Morocco.
GIZ. Grid Connection of Solar PV – Technical and Economical Assessment of Net Metering in Kenya 2011 page 49
http://kerea.org/wp-content/uploads/2012/12/Net_MeteringReport-Kenya.pdf

In 2014, PVPS Task 1 published an analysis for OECD countries. Accessible online:
http://iea-pvps.org/index.php?id=382

KPMG, an international accounting group, published in 2015 a comparative analysis of non-tax multi-country incentives. Accessible online: https://assets.kpmg.com/content/dam/kpmg/pdf/2015/09/taxes-and-incentives-2015-web-v2.pdf

On Energypedia: The following webpage provides general explanations on net-metering, how and where it has been applied (a list of countries with size limits for PV systems), pros and cons and success factors:
https://energypedia.info/wiki/Net_Metering

3. Evaluation of the relevance of net metering in specific contexts

3.1. Focusing on issues (SWOT analysis)

Strengths	***Weaknesses***
● Increased generation capacity ● Improved access to energy (clean and modern source) ● Diversification of the energy mix; on the long term: more decentralized generation with less dependence on a few big power plants (increase of network stability), requires less transmission capacity ● Promotion of small-scale private investment ● Increase in building value ● Strengthening the solar sector / job creation	● Reduced profit for the distribution company (but: depends on their own generation cost and tariff level) ● Associated administrative costs (adaptation of customer management) ● Possible technical constraints
Opportunities	***Threats***
● Urban growth ● Strong sunshine ● Dependency on imports / Supply instability ● Inability to invest in new large-scale power plants ● Service improvement objectives (e.g. ↑ electricity access / ↓ electrical losses / ↓ load shedding) ● Political objectives (Renewable energy development and Sustainable City) ● Decrease of PV equipment cost ● More and more experience feedback	● Political instability ● Inappropriate regulation ● Lobbying of distribution companies ● Inefficient data management system ● Poor coordination / lack of skills of actors ● Inability of clients to invest (limited access to investment funds) ● Availability of new low-cost fossil energy sources

Source: IED analysis from various sources, and discussions with experts

"The driving force should rather be the ambition to increase the share of renewable energies and the quality / resilience of the electrical service."

It should be noted that the large fluctuation of electricity tariffs (caused by fluctuating fossil fuel costs) can be both an opportunity and a threat. Indeed, if the cost of fossil fuels is the sole motivation for governments, then the political will fluctuates. The driving force should rather be the ambition to increase the share of renewable energies and the quality / resilience of the electrical service.

Many distribution companies fear revenue losses caused by net metering. In fact, utilities which introduce net metering normally have to deal with:

- Registration and procedure management,
- Training of dedicated staff,
- Follow up of growing numbers of prosumers and thus
- Setting up of appropriate technical limitations,
- Negotiations and reporting to the regulators
- Normally, a decrease in sales and
- A mostly long-term agreement between prosumer and utility (with respective pros and cons).

All these issues often make utilities reluctant to introduce net-metering.
The **positive aspects** include the increasing RE portion in the electricity mix (could be interesting in case of RPS or Green Certificates) and an often-improving level of service (could be interesting in case of quality standards objectives).
Still the most important criterion to decide on the introduction of net-metering should be a scenario calculation based on realistic assumptions, to get an idea of whether net metering leads to (financial) losses or gains. If electricity is anyway sold at a subsidized tariff or electricity bills are not paid by specific consumer groups (e.g. governmental institutions), net-metering can definitely bring advantages by reducing ongoing losses.

3.2. Best practices

These best practices result (i) from analysis of countries where net metering is functioning (ii) from analysis of experts (mostly from GIZ) supporting countries in net metering policy definition and implementation.

Start simple. Start with studies followed by a pilot phase that gives concrete evidence upon which to base the regulation.

Adapt regulatory framework as the number of prosumers increases. GIZ, which has accompanied the implementation of net metering in several countries, recommends a deployment in two phases[19]: (i) First phase where net metering is mainly addressed to those whose investment capacities are relatively high (e.g. industrial and commercial user rather than residential ones) and (ii) second phase where net metering becomes interesting to every type of user.

Be clear and precise. The regulatory framework must be clear and precise: at least detail the conditions of eligibility, the connection procedure, the responsibilities of each (who owns the meter, who verifies it) and the technical specifications (size of the system). Net-metering in group [20]or virtual net metering [21]are more complex practices that are not suitable to start with.

Simplify administrative procedures as much as possible to encourage the participation of all. Prospective prosumers may be discouraged by the costs of the procedures they have to support (for example some Philippines' distribution companies require an impact study costing about 96 USD[22])

Strengthen distribution companies' skills since they will have to set up a new billing system, understand the impact studies, manage disputes, etc.

Optimize the compensation scheme (the value the customers get for each injected kWh) i.e. (i) do not penalize the distribution company with a value that is too high (ii) be attractive for

[19] From EUIE-PDF Kenya 2013 « Assessment of a net metering programme in Kenya » report, published in 2014 and available online:
https://renewableenergy.go.ke/asset_uplds/files/Net%20Metering%20Assessment%20Report%20Volume%201.pdf

[20] Net metering in group: a group of consumers buy a production plant together and share the credits earned during the injection of surplus electricity

[21] Virtual net metering: net metering production plant is located away from the place of consumption

[22] Source: discussion with Mr. Ferdinand Larona, GIZ

customers. In order not to penalize the distribution company, there are several solutions: the value of one single injected kWh must be lower than or equal to the average cost of electricity production, or the quantity of injectable energy must be limited by the regulations, or distribution companies must receive financial assistance which may result in a specific tax. In addition, the cost of the meter should be the responsibility of the customer.

Only compensate the injected energy. If there is a problem on the network that prevents the energy from being injected, the customer must not receive compensation (no "deemed" generation under the concept of net metering).

Ensure the payment of taxes on electricity consumption: Tax payment should be based on the total energy consumption of a customer irrespective of whether this is produced by the prosumer or provided by the utility. Consequently, only for “expired” credits the prosumer does not pay a tax (because this tax is then paid by another customer who consumes the respective kWhs).

Prevent customers from becoming IPP: The injectable power must not be greater than the maximum mentioned in the sales contract, meaning the customer must be a net importer (in his relation to the utility) over a specified period. The amount of self-consumption does not play a role in this.

Be careful not to impact the networks: Even if this document does not focus on technical constraints, warning is a must. Some countries (India, for example) have power limits at the transformer station. For example, in Delhi, the power injected on the LV network must not exceed 20%[23] of the nominal power of the transformer station at any time. In Ghana, each distribution company is asked to publish an annual report on net-metering (see Ghana net metering Subcode – art. 37).

Monitor the implementation of laws: In many countries (such as Ghana or Cabo Verde), the issue consists in the regulation’s implementation rather than in regulations definition. It is necessary to have a strong political will and to put in place the necessary means to (i) translate the laws into action and (ii) follow the setting up and development with periodic reports.

Choose between net metering and prepayment: In the studied countries, net metering and prepayment do not seem to be compatible. In South Africa for example, "prepaid" customers moving towards net metering must change meters. Studies are underway on the subject (Ghana[24], South Africa).

As a general rule, the feedback from other countries should be used to optimize the regulatory framework and help from international experts such as the German International Cooperation (GIZ) which has provided technical assistance in several developing and emerging countries.

3.3. Quick review of technical issues

Even if this study does not concern the technical or urbanistic aspects, it will be necessary to take them into account at the time of the reflection, in particular:

- Impact on the distribution networks

[23] Bridge to India : : http://www.bridgetoindia.com/wp-content/uploads/2017/12/India-Solar-rooftop-Map-Dec.pdf [en ligne]

[24] Ghana : Pilot study is ongoing, net meters are installed in series with pre/post paiement meter (voir : http://energycom.gov.gh/refair/files/ECG.pdf)

- Capacity building needs assessment
- Fire safety
- “Right to the sun” / shading
- Panel recycling line

Studies were conducted on some of these topics, notably by GIZ, which has accompanied the implementation of laws regulating net metering in several countries.

3.4. Case Studies

The purpose of this section is to present systems actually connected under net metering contract with the main features of their operation.

The Philippines

The 2 studies below were carried out by GIZ and published in the "Net-metering reference guide" report[25] (in 2013, the specific cost e.g. USD per Wp are still valid today). The payback times are around 7 years.

Nominal Power	5 kWp rooftop on a Bank[26] - Ayala Avenue Extension, Makati City
Features	20 solar panels (CS6P 245) 2 inverters (SMA) 1 mounting structure (Mp Tec) 1 Web box (SMA)
Payback time	7 years
Images	  

Nominal power	8.46kWp at a private individual - Mr Tom Thomas, Sta Rosa, Laguna
Features	34 solar panels (MP TEC S-LINE 240) 2 inverters (SMA Sunny Boy 7000 et SMA Sunny Boy 2500) 1 mounting system (Mp Tec) 1 Web box (SMA)
Payback time	6-7 years
Images	  

Calculations of payback time were made by Markus Dietrich (consultant at GIZ) – see footnote 24.

Ghana

A pilot study is underway but the results are not available at the time of writing this report.

India

A study published in 2015 by Jagruti Thakur and Basab Chakraborty[27], “Sustainable net metering model for diversified India”, simulated the benefits of 10 urban prosumers based on surveys (to know the consumption habits) and based on the following assumptions:

[25] Markus DIETRICH, GIZ. 2013. Net-metering reference guide pp 38-45 [online] https://www.doe.gov.ph/sites/default/files/pdf/netmeter/net-metering-reference-guide-philippines-E.pdf

[26] Bank of the Philippine Islands (BPI)

[27] 1876-6102 © 2016 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

Parameters	Value
Total load supported	80%
Load growth rate	+1.2%/year
Inverter efficiency	96%
Module efficiency	15%
AC to DC ratio	1.1
Inclination (degrees)	30
Losses	14,08%
Degradation	-0.5%/year
O&M costs	2400 Rs /year

Parameters	Value
Year-end sale for net metering	7.2 Rs
Fixed monthly charges	10 Rs.
Minimum monthly charges	28 Rs.
Loan (% of total capital)	70%
Loan interest	5% / year
Loan term	10 years
Inflation	8.35% /year
Period of analysis	25 years
Electricity cost escalation rate	+9.38%/year

All simulations were performed with an NREL simulation tool[28], considering (i) that the electricity company is WBSEDCL (West Bengal State Electricity Distribution Company Limited) (ii) that the system size is calculated with the following formula:

$$Size\ of\ system = {}^{Annual\ consumption\ units}/_{CUF\ \times 24\ \times 365}$$

where Capacity Utilization Factor is calculated from a real 100 kWp solar plant.

The payback period varies from 8.3 to 10.5 years.

The study from which this data was extracted is available on: https://ac.els-cdn.com/S1876610216302089/1-s2.0-S1876610216302089-main.pdf?_tid=a47540ee-b8ef-4c0b-b270-a79dc5161391&acdnat=1525091004_6b6047165681e062c035033f23d4c185

(http://creativecommons.org/licenses/by-nc-nd/4.0/). Peer-review under responsibility of the organizing committee of CUE 2015 doi: 10.1016/j.egypro.2016.06.139

[28] SAM software, available on https://sam.nrel.gov/

4. Commercial opportunities resulting from net metering

4.2. Potential economic impacts

The introduction of net metering can open up commercial prospects not only for the prosumers but also for many companies, particularly in the following sectors:

- Training (capacity building for distribution companies' staff, electrical issues as well as computing)
- Technical / legal expertise / support for the implementation of policies, i.e. consultancy assignments for decision-makers
- Supply of solar equipment (solar panels, electronic equipment, meters, etc.). International companies interested in this market will have to be careful about customs taxes which can be unpredictable.
- Provision of hardware and IT solution (billing software solution, monitoring the implementation of net metering).

4.2. Programmes promoting renewable energy and energy efficiency

See country datasheets (in Appendix) where some noteworthy programmes are presented.

4.3. New business models

The acquisition of a solar power plant by individuals wishing to benefit from net metering entailed the emergence of several business models:

Cash payment	« Lease-to-own »	Sale / Purchase agreement
● Purchase at one time ● The customer owns the system ● Payment at or directly after installation	● None / Low initial contribution from the client ● The customer becomes the owner of his system after a rental period ● Regular payments usually for 3 to 7 years	● None / Low initial contribution from the client ● The installer owns the system. The property can be transferred to the client (prosumer) after a certain period (typically 5 years) ● Regular payments (from client to the installer) for generated energy

Source: From GIZ presentation from S. BEHLRE "Business Models for Distributed RE Generation in Ghana – with or without net-metering" Nov 2017 - page 17 http://ghana.ahk.de/fileadmin/ahk_ghana/Documents/RES_Manufacturing_Industries_in_Ghana/Business_Models_for_Distributed_RE_Generation_in_Ghana_-_with_or_without_Net-Metering_Presentation_compressed.pdf

For further information

When regulation allows more complex compensation schemes such as geographic compensation or net metering in group; other businesses can emerge. See Appendix 4 for a presentation of business models that can be found in India.

4.4. Market trends

Investing in renewable energy means investing in a future market that is growing. Several experts rank countries according to their economic attractiveness, as, for example:

- The ranking of the Word Bank "Ease of doing business": https://data.worldbank.org/indicator/IC.BUS.EASE.XQ
- Ernst and Young's "Renewable Country Attractiveness Index (RECAI)" ranking specific to the renewable energy sector: https://www.ey.com/gl/en/industries/power---utilities/renewable-energy-country-attractiveness-index

5. Conclusion

From data collection done in a selection of 8 countries, literature review and interviews with experts, an inventory of net metering best practices was made.

Most important results are the 3 following points:

① In-depth analyses are necessary prior to setting up any compensation schemes. On the one hand, the distribution companies' fear of revenue losses has to be taken into account otherwise they might be reluctant to support and promote net metering. On the other hand, compensation schemes should be attractive enough to promote net metering amongst clients whose investment capacities are limited. Subsidies from governments can help.

② Strong political will is necessary to turn the law into concrete achievements. If the cost of fossil fuels is the sole motivation of governments, then the political will fluctuates. Instead, an actual ambition to increase the share of renewable energies and the quality / resilience of the electrical service is a key to successful implementation of net-metering. Moreover, a strong political will is necessary to set up an efficient and user-friendly registration procedure for people willing to join the net metering programme.

③ It seems that net metering development in emerging countries can be split into two phases (i) First phase where net metering is mainly addressed to those whose investment capacities are relatively high (e.g. industrial and commercial user rather than residential ones) and (ii) second phase where net metering becomes interesting to every type of user.

6. Appendix 1: Acronyms

Acronym	Explanation
ARSE	Autorité de Régulation du Sous-secteur de l'Electricité (Burkina Faso's regulator)
BoS	Balance Of System
BNEF	Bloomberg New Energy Finance
CEB	Communauté Electrique du Bénin (Utility in charge of generation & transmission in Benin)
CENECO	Central Negros Electric Cooperative (a Philippine distribution company)
COOPEL	COOPerative ELectrique
CSIR	Council for Scientific and Industrial Research
ECG	Electricity Company of Ghana (in charge of distribution)
ECOWAS	Economic Community of West African States
ECREEE	Ecowas Centre for Renewable Energy and Energy Efficiency
ELECTRA	Cape Verdean electricity and utility company
EUIE	European Initiative for Energy
FCFA	Franc CFA (currency used in parts of West and Central African countries)
GERMI	Gujarat Energy Research & Management Institute (India)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSA	Ghana Standards Authority
GW	Giga Watts
ICLEI	Local Governments for Sustainability
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
IRESEN	Research Institute for Solar Energy and New Energies (Morocco)
IT	Information Technology
KPLC	Kenya Power: company in charge of transmission and distribution in Kenya
LED	Light Emitting Diod
MERALCO	Manila Electric Company (a Philippine distribution company)
MW	Mega Watt
NAMA	Numeracy for Advanced Manufacturing
NEA	National Electrification Administration
NERSA	National Energy Regulator (of South Africa)
NMBM	Nelson Mandela Bay Municipality
NREL	National Renewable Energy Laboratory
NSRP	National Solar Rooftop Programm
OECD	Organisation for Economic Co-operation and Development
PURC	Public Utilities Regulatory Commission (Ghana)
PVPS	Photovoltaic Power Systems Programme
RE	Renewable Energy
RECAI	Renewable Country Attractiveness Index
ROI	Return Of Investment
RPS	Renewable Portofolio Standard

SALGA	South African Local Government Association
SAPVIA	South African Photovoltaic Industry Association
SBEE	Société Béninoise d'Energie Electrique (Benin national utility in charge of distribution)
SEA	Strategic Environmental Assessment
SERC	State Electricity Regulatory Commissions (in India)
SONABEL	SOciété NAtionale d'ELectricité du Burkina Faso (Burkina Faso's national utility)
SSEG	Small Scale Embedded Generation
SWOT	Strengths Weacknesses Opportunities Threats
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development

7. Appendix 2: Glossary

Discom: shortened form of distribution company

Feed-In Tariff: The feed-in tariff is an incentive mechanism in which production and consumption are not linked. The feed-in tariff only concerns production. It allows the producer to be paid for the amount of energy he injects into the grid according to a contract established between the producer and the grid operator.

Geographical compensation (or virtual net metering): that is to say that the production plant can be located away from the place of consumption. According to regulations, "geographical compensation" may be permitted or prohibited. Geographic compensation may involve:
- Only one prosumer (who has a power station on a place other than the place of consumption)
- Several players (the owner of the system can either use the earned credits for himself or forward the earned credits to someone else - for free or according to a commercial agreement).

Net metering: is a type of contract that binds a customer and his energy distributor. In this contract, the customer is both a consumer and producer of electricity (for example, he/she has a rooftop solar power plant). The customer consumes electricity from his plant in real time (no storage) and surplus electricity is injected into the grid. For each injected kWh, the consumer gets compensation in the form of credit.

Net metering in group: that is to say that a group of consumers buy a production plant together and share the credits earned during the injection of surplus electricity.

Prosumers: a customer who consumes his electricity and who injects the surplus into the grid. The word comes from the English terms 'consumer' and 'producer', which means that a prosumer is both a consumer (buying electricity from the grid) and a producer (injecting electricity into the grid).

"Third party ownership" or **"Ownership of a third party":** This term refers to the fact that the production system does not belong to the prosumer but to a third party who rents it to the prosumer. According to regulations, the "property of a third party" may be permitted or prohibited.

8. Appendix 3: System limits in India

States	Injected power limit vs subscribed power	Maximum injected power	Max. share of injected energy with regards to consumed energy	Max PV power injected with regards to transformer's capacity
Andhra Pradesh	None	1MW	n/a	60%
Maharashtra	100%	1MW	n/a	40%
Uttar Pradesh	100%	1MW	n/a	15%
Gujarat	50%*	1MW	n/a	65%
Tamil Nadu	100%	None	90%	30%
Rajasthan	80%	1MW	n/a	30%
Goa	n/a	0.5MW	30%	30%
Karnataka	n/a	1 MW	n/a	80%
Madhya-Pradesh	100%	0.25 MW	n/a	15%
Telangana	50%	1 MW	n/a	30%
Haryana	100%	1 MW	90%	15%
Punjab	80%	1 MW	90%	30%
Chhattisgarh	n/a	1 MW	49%	n/a
Kerala	n/a	1 MW	n/a	15%
Odisha	100%	None	90%	75%
Jharkhand	100%	1 MW	n/a	15%
Bihar	None	1 MW	90%	15%
Delhi	None	1 MW	n/a	20%
West Bengal	n/a	None	90%	n/a
Jammu & Kashmir	50%	1 MW	90%	20%
Uttarakhand	n/a	0.5 MW	95%	n/a
Chandigarh	n/a	0.5 MW	30%	30%

Source: Bridge To India. India Solar Rooftop Map 2017.
[online] http://www.bridgetoindia.com/reports/india-solar-map-september-2017/

9. Appendix 4: Solar Rooftop business model

	Self ownership		Third party ownership			Other models
	Capex (on-site consumption)	**Capex (grid export)**	**Rooftop leasing**	**PV system leasing**	**Solar power purchase agreement**	**Hybrid ownership**
Description	PV system is owned by the rooftop owner and electricity is generated for self consumption only.	PV system is owned by the rooftop owner and electricity is generated for self consumption. Surplus electricity is sold to the grid through net metering. Alternatively system can be built for total grid export under gross metering.	A developer leases the roof from the property owner and pays a rooftop lease/rental. Electricity generated is sold to the grid at the feed-in-tariff determined by the regulator. System is owned by developer.	Rooftop owner signs a lease agreement with the lessor to make monthly payments over an agreed period of time. System continues to be owned by the developer. Major benefit is no upfront capital requirement to the consumer.	Rooftop owner signs a PPA with a third party developer and enters in to a net metering arrangement with the discom. The ownership of the system lies with the developer. Major benefit is no upfront capital requirement to the consumer.	Rooftop owner puts a small equity investment while the developer puts the rest/arranges debt from the bank/other investors. Such systems have joint ownership to avoid regulatory hurdles in net metering.
Financing	The owner pays for the system upfront and may or may not arrange debt from the banks or other financial institutions.	The owner pays for the system upfront and may or may not arrange debt from the banks or other financial institutions.	The developer puts in the equity investment in the project and arranges debt from the bank/other investors.	The developer puts in the equity investment in the project and arranges debt from the bank/other investors.	The developer puts in the equity investment in the project and arranges debt from the banks/other investors.	Rooftop owner and the developer put an equity investment and arrange debt from bank/other investors.
Performance risk	Performance risk lies with the consumer.	Performance risk lies with the consumer.	Performance risk lies with the developer.	Performance risk lies with the developer.	Performance risk lies with the developer.	Performance risk lies with the developer
Operations and maintenance	Responsibility of the consumer (if no O&M contract)	Responsibility of the consumer (if no O&M contract)	Responsibility of the developer	Responsibility of the developer	Responsibility of the developer	Responsibility of the developer
Accelerated depreciation benefits	Benefits are claimed by the rooftop owner.	Benefits are claimed by the rooftop owner.	Benefits are claimed by the third party investor/developer.	Benefits are claimed by the third party investor/developer.	Benefits are claimed by the third party investor/developer.	Benefits are claimed by the rooftop owner.

Source : Bloomberg New Energy Finance's Analyse 2017. "Accelerating India Clean Energy Transition - The future of rooftop PV and other distributed energy markets in India. [online] https://data.bloomberglp.com/professional/sites/10/BNEF_Accelerating-Indias-Clean-Energy-Transition_Nov-2017.pdf

References

Net metering review and best practices

● See “For further information” sections, in paragraphs 2.3 to 2.10

● GIZ. Grid Connection of Solar PV – Technical and Economical Assessment of Net Metering in Kenya 2011 page 53
http://kerea.org/wp-content/uploads/2012/12/Net_MeteringReport-Kenya.pdf

● EUEI-PDF Kenya 2013 Project Renewable Energy Regulator Capacity Development – Assessment of a net metering programme in Kenya. Volume 1 Main Report. March 2014 page 25. http://www.renewableenergy.go.ke/asset_uplds/files/Net%20Metering%20Assessment%20Report%20Volume%201.pdf

● USAID. Lessons learned from various approaches in scaling up solar rooftop, 2017
https://d2oc0ihd6a5bt.cloudfront.net/wp-content/uploads/sites/837/2017/06/3_Lessons-learned-from-various-approaches-in-scaling-up-solar-rooftop-Boonrod-Yaowapruek.pdf [online] data dated January 29th 2018

● Patrick Curran and Gerrit W. Clarke. Review of Net Metering Practices, 2012 [online]
http://www.reiaon.com/wp-content/uploads/downloads/2013/02/Review_of_NetMetering_Practices_v1.pdf

Tool for ROI estimates

Markus Dietrich, GIZ. Net metering reference guide, 2013 pages 34-35 [online]
https://www.doe.gov.ph/sites/default/files/pdf/netmeter/net-metering-reference-guide-philippines-E.pdf

Specific information to ECOWAS countries

● ECREEE Electronic gateway with electricity data for each country
http://www.ecowrex.org/

Comparison between net metering and other incentives

● Net metering VS Feed-In-Tariff
GIZ. Grid Connection of Solar PV – Technical and Economical Assessment of Net Metering in Kenya 2011 (p26)

● Net metering in groups VS geographic compensation
Gujarat Energy Research & Management Institute (GERMI).
https://germipower.wordpress.com/2016/07/12/why-is-virtual-net-metering-the-next-big-thing-in-the-indian-rooftop-solar-market/

Documentation on related topics

● Demand / production adequacy: “The Challenge of shifting peak electricity demand”
https://www.nesta.org.uk/sites/default/files/the_challenge_of_shifting_peak_electricity_demand.pdf

● Industrial prosumers in Africa : UNIDO. Industrial Prosumers of Renewable Energy, Contribution to Inclusive and Sustainable Industrial Development 2015 [online]
https://www.unido.org/sites/default/files/2015-04/PROSUMERS_Energy_0.pdf

For further information about the IEA – Photovoltaic Power Systems Programme and Task 9 publications, please visit www.iea-pvps.org.

Country datasheets

PVPS Study "Net metering and PV self-consumption in emerging countries"
conducted by IED in the frame of an IEA collaborative technical research programme

BENIN

Net metering

- **Net metering is not allowed.**
- **Regulations focus on implementing a framework for RE self-consumption, for both on-grid and off-grid installations, with the support of ECREEE and GIZ.** The following decree will be adopted as soon as the law will come into force : "Promotion de l'autoproduction et de l'autoconsommation de l'électricité à base d'énergies renouvelables avec ou sans injection sur le réseau"
- **Max. size of PV system**
- **Compensation**
- **Drivers**
- **Incentive to help customers to invest in PV**: Exemption from VAT and duty import tax since 2013

Sources: IED

Grid configuration and energy sector

- **Electricity network is made up of national grid and mini-grids**

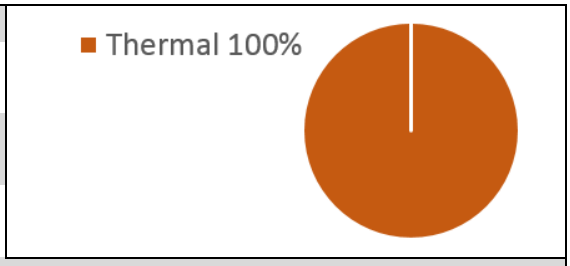
Ministry	Ministry of Energy
Regulators	ARE (Autorité de Régulation de l'Électricité)
Transmission	CEB (Communauté électrique du Bénin) : is responsible for import/export and transmission to both Togo and Benin territories
Generation	IPPs
Distribution	SBEE (national state-owned utility)
Others	ABERME implements the policies regarding rural electrification and energy efficiency ANADER (dissolved in 2017) was in charge of RE development including projects assessments and funding

Urban sector facts & figures and residential customers

- **Main cities** *(Source https://www.citypopulation.de/Benin-Cities.html?cityid=2054)*
  1. Cotonou 617 012 inhabitants (2013)
  2. Porto-Novo 264 320 inhabitants (2013)
  3. Parakou 255 478 inhabitants (2013)
- **Total population (2017)** 11.2 million *(Source https://www.unfpa.org/fr/data/world-population/BJ)*
- **Percentage of urban** population **(2016)** 44.4% *(Source World Bank)*
- **Urban average growth rate (2006-2016)** +0.96%/year *(Source World Bank)*
- **Forecast / Trends about residential customers:** urban development forecast is estimated +2.74%/year until 2020 (World bank estimates)
- **Energy usage breakdown:** n/a

Electricity sector facts& figures

Installed capacity[1]	about 112MW (Benin+Togo)
Evolution of peak power demand[2] (2003-2016)	Average growth rate +6%/year
Dependence on energy imports[3]	High (Ivory Coast, Nigeria, Ghana, Niger)
Supply VS Demand[4]	Demand > Production
Losses[5]	Technical losses about 23-24 % since 2014
Blackouts[6]	Total duration in 2016 129h
Efficiency and financial soundness of Utility[7]	Poor
Solar potential[8]	3,9 kWh/m²day - 6,2 kwh/m²day



Sources:

1 - CEB Website / Agence Ecofin

2- 2003 and 2013 data from www.24haubenin.info / 2014 IED / 2015 CARDNO FICHTNER http://docplayer.fr/32357271-Rapport-d-etude-de-faisabilite-sur-le-systeme-de-distribution.html / 2016 MCA SBEE

3- CEB website

4- SBEE Annual report2016

5-SBEE Annual Report 2016

6- SBEE Annual Report 2016

7- SBEE Annual Report 2016

8-Website: http://www.bj.undp.org/content/dam/benin/docs/environnement/rapport-developper-benin-energies-renouvelables.pdf p10

Tariff scheme

- **Retail price**[1]

	Prepayment	Post-payment
Fixed charges	Meter rental and maintenance: 0.9USD (5A) or 36USD (60A) Public Lighting tax: (amount of consumed kWh times 2 or 3) Tax to support rural electrification (amount of consumed kWh times 3)	
Retail price /kWh	<u>Domestic segment</u> <20kWh/month: 0.13USD/kWh + VAT exemption <u>Commercial segment</u> <250kWh/month:0.2 USD/kWh + 18%VAT	<u>Unique price</u> 0.2USD/kWh +18%VAT

- **Prepayment exists**[1]
- **Feed-In-Tariff:** Yes since 2014
- **Taxes**[2]**:** Exemption of VAT and duty import tax for solar products since 01/01/2009

Sources:

1- SBEE invoice

2- Benin regulations

Noteworthy programme or political will regarding RE and EE

Programme EnDev (Energizing Development) from GIZ, providing both financial and technical assistance.
Programme Pay As You Go from SNV, sales of solar lantern thanks to PAYG company Angaza: *http://www.snv.org/update/introducing-pay-you-go-solar-products-benin*

Additional sources

➔ Statistics: http://www.insae-bj.org/

➔ Utility website: https://www.sbee.bj/site/nos-activites/production-delectricite/

PVPS Study "Net metering and PV self-consumption in emerging countries"
conducted by IED in the frame of an IEA collaborative technical research programme

BURKINA FASO

Net metering

- **Net metering is not allowed.**
- **Regulations are focusing on** the implementation of a Feed-In-Tariff for IPPs.
- **Max. size of PV system**
- **Compensation**
- **Drivers**
- **Incentive to help customers to invest in PV**: Exemption of VAT and duty import tax since 2013

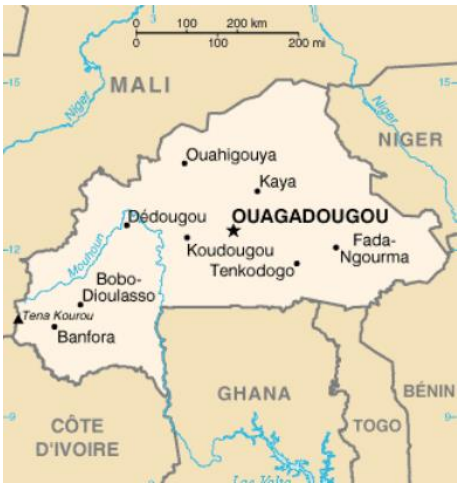
Sources: IED

Grid configuration and energy sector

- **National grid (91% of the total energy sold in 2014) – which is called "segment 1" and consists of urban areas coverage, along with Off-grid (9% of the total energy sold in 2014) – which is called "segment 2" and mostly concerns rural areas**

Ministry	DGE (Directorate General of Energy) is the politic entity in charge of energy
Regulators	ARSE (Autorité de Régulation du Sous-secteur de l'Electricité (Electricity Sector Regulatory Authority)
Transmission	The national utility SONABEL has the monopoly of the transmission network throughout the territory (> 33 kV) and the monopoly of the distribution
Generation	SONABEL + private companies
Distribution	The national utility SONABEL has the monopoly of in the 1st segment COOPEL are in charge of supply and exploitation of their mini-grids
Others	FDE (Fonds de Développement de l'Electrification; Electrification Development Fund): Implements the national plan for rural electrification, seeks financing, monitors and controls rural electrification activities. Regions & Municipalities: develop regional electrification master plans (Region), create and manage energy infrastructure e.g. public lighting (municipalities)

Urban sector facts & figures and residential customers



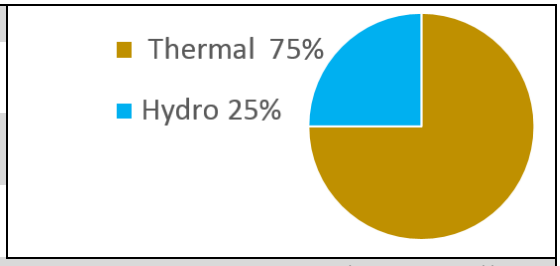
- **Main cities** *(source census 2006)*

① Ouagadougou 1 475 223 inhabitants
② Bobo-Dioulasso 489 967 inhabitants
③ Koudougou 88 184 inhabitants

- **Total population (2017)** 19.2 million *(https://www.unfpa.org/fr/data/world-population/BF)*
- **Percentage of urban** population **(2015)** <30%
- **Urban average growth rate (2006-2016)** +3.3%/year *(Source World Bank)*
- **Forecast / Trends about residential customers:** on segment 1, i.e. mainly not rural area, the customers number grew +9% in 2013/2014
- **Energy usage breakdown:** n/a

Electricity sector facts& figures

Installed capacity[1]	325 MW (2015) see energy mix
Evolution of peak power demand[2] (2012-2016)	Average growth rate +11.7% / year
Dependence on energy imports[3]	High, 36% of energy sold by SONABEL is imported (Ivory Coast, Togo, Ghana)
Supply VS Demand[4]	Demand > Production
Losses[5]	Technical 17.2% (Tech+Non Tech losses vary between 11% and 14% (2002-2013))
Blackouts[6]	More than 50% of non-distributed energy is due to blackouts In 2015, blackouts represent 340 hours
Efficiency and financial soundness of Utility[7]	Low (17 billion € deficit in 2015). Since 2009, average retail price (0.22USD/kWh in 2015) is lower than average production cost (0.25USD/kWh in 2015)
Solar potential[8]	4 to 6 KWh/m2/day



Sources:

1 - SONABEL Annual Report 2015
2 - ARSE Annual Report 2014
3 - ARSE Annual Report 2014
4 - IED
5 - ARSE – Annual Report 2014
6- ARSE website http://www.arse.bf/IMG/pdf/statistique_dusecteur_2013.pdf + SONEABEL, Annual Report 2015
7- SONABEL Annual report 2015
8- ARSE https://www.arse.bf/spip.php?article28

Tariff scheme

- **Retail price[1]:** 75 to 138 FCFA/kWh depending on segments
- **Prepayment: exists[1]** (16% of LV SONABEL's customers use prepayment, all others use post payment)
- **Feed-In-Tarrif[2]: No** (under discussion since more than one year)
- **Taxes[2]:** Exemption of VAT and duty import tax for solar products, from panels to solar fridge since 2013

Sources:

1 - SONABEL website
2 - IED

Noteworthy programme or political will regarding RE and EE

A pilot study about grid-connected solar plants was conducted in 2017 in order to prepare the implementation of a PV Feed-In-Tariff.

Solar Power plant of Zagtouli (33MWp) was inaugurated in September 2017. The peak power will be increased to reach 50MWp in 2019. The European Union and Agence Française du Developpement gave EUR 47 million (grant) to finance the construction of the power plant. *(Source: SONABEL website: http://www.sonabel.bf/index.php/nous-suivre/actualites/471-inauguration-de-la-centrale-solaire-photovoltaique-de-zagtouli)*

Additional sources

➔ Statistics: http://www.insd.bf/n/
➔ Activity report of the regulation authority (ARSE): https://www.arse.bf/spip.php?rubrique6

PVPS Study "Net metering and PV self-consumption in emerging countries"
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CABO VERDE

Net metering

- **Net metering is allowed but there is no concrete result as per February 2018.** A significant number of PV systems are already installed. The owners of some of these systems even installed bidirectional meters as required by the law and informed the Ministry of Energy and/or Electra utility[1]. However, none of the owners receives any credit for the fed-in electricity from Electra. Cabo Verde is planning to conduct an inventory of grid-connected solar systems (with World Bank Support, SIDS-DOCK project) and to resolve situations of systems that are illegally feeding into the grid[2].
- **A legal basis for net metering exists since 2011.** Net metering ("microgeneration") is one of the three regimes introduced through the renewable energy law of 2011 (see Decreto-lei nº 1/2011 of January 3rd, 2011)**. The Ministry is planning to amend this law and to operationalize the microgeneration scheme in** 2018[1].
- **Max. size of PV system[3]** is the minimum value among
  - **(i) 100kWp**
  - **(ii) 85% of the energy consumed (at this connection) during the previous year**
  - **(iii) 25% of the maximum capacity of the electricity connection as per sales contract with the utility**
- **Compensation** According to art. 23 of the law, the compensation is 1:1 (based on the end-user tariff)
- **Drivers** The will to increase RE in the mix led to net metering regulation
- **Incentives to help customers invest in PV**: The RE law of 2011 includes some incentives[3], but whether they apply to microgeneration or not is not clear. Applicant has to pay application fees.

Sources:

1- *from d*iscussions with Lucius Mayer-Tasch, GIZ

2- http://documents.worldbank.org/curated/en/836461513968461907/Cabo-Verde-Distributed-Solar-Energy-Systems-Sids-Dock-Project-restructuring

3- http://www.are.cv/index2.php?option=com_docman&task=doc_view&gid=290&Itemid=42

Grid configuration and energy sector

Ministry	Cabo Verde Ministry of Industry, Commerce and Energy
Regulators	ARE
Transmission	ELECTRA
Generation	ELECTRA
Distribution	ELECTRA

Urban sector facts & figures and residential customers

- **Main cities**

① Praia 127 832 inhabitants (2010)

② Mindelo 70 468 inhabitants (2010)

(https://www.citypopulation.de/CapeVerde.html?cityid=12759)

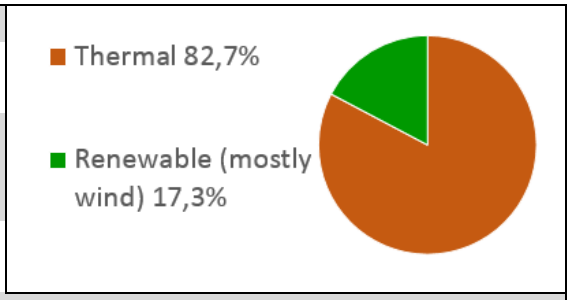
- **Total population** 520 500 (according to World Bank's 2017 estimates)

(Source : http://www.worldbank.org/en/country/caboverde/overview)

- **Percentage of urban (2015)** 65.5% *(Source: World Bank)*
- **Urban average growth rate (2005-2015)** +1.3%/year *(Source World Bank)*
- **Forecast / Trends about residential customers:** n/a
- **Energy usage breakdown:** n/a

Electricity sector facts& figures

Installed capacity[1]	168,4 MW (2016) see energy mix
Evolution of peak power demand[2] (2012-2016)	Average growth rate +2.56% / year
Dependence on energy imports[3]	Very high 82.7% of electricity production is thermal (imported fuel oil and diesel).
Supply VS Demand[4]	n/a
Losses[5]	25.7% in 2007
Blackouts[6]	In 2016, customers were without electricity during 59.5 hours (SAIDI) In 2016, customers suffered from 36.5 power outages (SAIFI)
Efficiency and financial soundness of Utility[7]	Low. Net income 2016/2017 is negative
Solar potential[8]	6 kWh/m²/day



Source:

1 - Electra Annual Report 2016 page 18 http://www.electra.cv/index.php/2014-05-20-15-47-04/relatorios-sarl

2- Electra Annual Report 2014 and 2016 http://www.electra.cv/index.php/2014-05-20-15-47-04/relatorios-sarl

3- from discussions with Lucius Mayer-Tasch, GIZ

4- n/a

5- https://expressodasilhas.cv/economia/2018/02/25/perdas-totais-na-distribuicao-causam-prejuizos-de-27-milhoes-de-contos/56791

6- Electra Annual Report 2016 page 8 http://www.electra.cv/index.php/2014-05-20-15-47-04/relatorios-sarl

7- Electra Annual Report 2016 page 7 http://www.electra.cv/index.php/2014-05-20-15-47-04/relatorios-sarl

8- IRENA RENEWABLE ISLANDS:SETTINGS FOR SUCCESS. Page 6 http://www.irena.org/publications/2014/Jun/Renewable-islands-Settings-for-success

Tariff scheme

● **Retail price**[1] a lifeline tariff for the first 60kWh (very low tariff for the first kWh, if you consume more, you pay the normal tariff for the entire consumption) + a normal tariff (0.25-0.3cts€/kWh in 2017; tax is 15% of the total) There was a 17 % decrease in electricity tariff between 2015 and 2017.

● **Prepayment exists**[2] most of customers are postpaid but prepayment exists

● **Feed-In-Tariff**[3] **Yes** (so far only in the law – ARE has not published any tariff yet)

●**Taxes**[4]**:** Special Consumption Tax (ICE) of 0.5%, VAT is 15% on PV equipment.

Sources:

1- http://www.are.cv/index.php?option=com_content&task=view&id=261&Itemid=140 + Electra Annual Report 2016 p4

2- *from d*iscussions with Lucius Mayer-Tasch, GIZ

3- Various source

4- *from d*iscussions with Lucius Mayer-Tasch, GIZ

Noteworthy programme or political will regarding RE and EE

National Energy Policy: Government of Cabo Verde has the ambitious plan to achieve 50% renewable energy share in the electricity mix by 2020. Source: Government of Cape Verde. Action plan is available online: https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/Action_Agenda_Sustainable_Energy_4_All_SE4ALL_CBV_-_Eng.pdf

Additional sources

➔ Statistical Institute: INE http://ine.cv/

➔ Monetary, financial and external sector statistics :http://www.bcv.cv/vEN/Estatisticas/Quadros%20Estatisticos/Paginas/QuadrosEstatisticos.aspx

➔ ECREEE/GIZ: http://www.ecreee.org/sites/default/files/event-att/reforming_and_operationalizing_cabo_verdes_scheme_for_distributed_re_generation_2016-05-27.pdf

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GHANA

Net metering

- **Net metering is allowed but no concrete results as per February 2018. One pilot study is on-going.**
- **Regulations exist since 2015** (see Net Metering Sub Code[1]). A programme called "National Solar Rooftop Programme"[2] (NSRP) was launched in 2016 by the Energy Commission and the Ministry of Energy aiming at the generation of 200 MW from PV source.
- **Max. size of PV system: 200 kWp[1].** Moreover, the "National Solar Rooftop Programme"[2] (NSRP) deals with for installations below 500kWp. Some information on this programme is available online[2], such as a list of partner banks and a list of 80 solar vendors. Unfortunately, this information is not up to date as per February 2018.
- **Compensation is equal to retail cost**, in other words, one customer gets 1kWh credit for each kWh he/she injects into the grid
- **Drivers** n/a
- **Incentives to help customers invest in PV**: Applicants are requested (i) to pay BOS, to pay for bi-directional meter (that will be installed by the Utility), and also (ii) to use energy saving devices (like LED lightbulbs), while either panels or cash payment will be provided as incentives as per "National Solar Rooftop Programme".

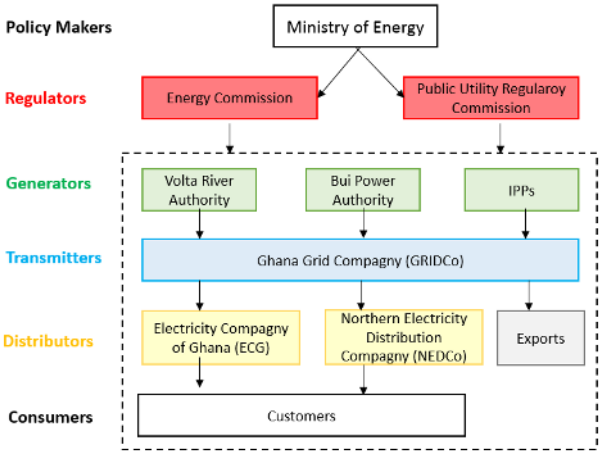
Sources :

1- *http://energycom.gov.gh/files/Net%20Metering%20Sub-Code%2C%202015.pdf*

2- http://energycom.gov.gh/rooftopsolar/ and http://rooftopsolar.energycom.gov.gh/about-nrp

Grid configuration and energy sector

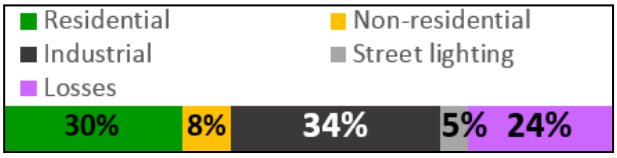
2 independent networks operated by ECG and NEDCo respectively, see:
http://www.gridcogh.com/fr/national-grid.php



Sources :
Map : Wikimédia
Graph : See on the verso, Electricity sector facts& figures section, source 2

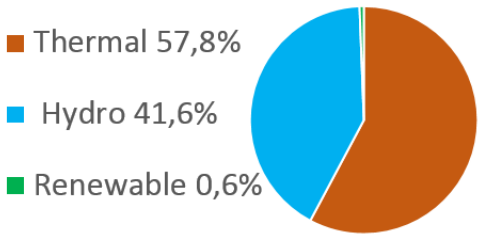
Urban sector facts & figures and residential customers

- **Main cities** (Source: http://www.devinfo.org/ghanainfo/libraries/aspx/Home.aspx)
  1. Accra 1 665 086 inhabitants (2010)
  2. Kumasi 1 730 249 inhabitants (2010)
  3. Sekondi Takoradi 556 548 inhabitants (2010)
- **Total population (2017)** 28.8 million *(Source : https://www.unfpa.org/fr/data/world-population/GH)*
- **Percentage of urban population (2016)** 54% *(Source: World Bank)*
- **Urban average growth rate (2006-2016)** +0.7%/year *(Source: World Bank)*
- **Forecast / Trends about residential customers:** n/a
- **Energy usage breakdown (2015) see graphic** *Source: Ebenezer Nyarko Kumi. 2017. "The Electricity Situation in Ghana: Challenges and Opportunities." CGD Policy Paper. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/electricity-situation-ghana-challenges-and-opportunities*



Electricity sector facts& figures

Installed capacity[1]	3,7776 MW (2016) see energy mix
Evolution of peak power demand[2] (2006-2016)	Average growth rate +4.29% / year
Dependence on energy imports[3]	No (Exports to Togo, Benin, Burkina Faso)
Supply VS Demand[4]	Production > Demand
Losses[5]	2016: 23.2% (ECG 16.2% NEDCo 2.8% Transmissions 4.1%)
Blackouts[6]	2016 ECG (metro – urban- rural) / 2016 NEDCo (metro – urban- rural) SAIDI (hrs) ECG (27 – 39 – 47) / NEDCo (nc – 42 – nc) SAIFI (times) ECG (60 – 67– 72) / NEDCo (nc – 41 – nc) CAIDI (hrs) ECG (2 – 1– 2) / NEDCo (nc – 1 – nc)
Efficiency and financial health of Utility[7]	n/a
Solar potential[8]	4 to 6 kWh/m² /day



Source:

1 - Energy Outlook for Ghana 2017 page 18

2 - Ebenezer Nyarko Kumi. 2017. "The Electricity Situation in Ghana: Challenges and Opportunities." CGD Policy Paper. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/electricity-situation-ghana-challenges-and-opportunities

3 - IRENA. Ghana Renewables Readiness Assessment page 11

4 - idem 2

5 - idem 2

6 - Energy Statistics 2017 http://www.purc.com.gh/purc/sites/default/files/Tariff_proposal_for_2013_ECG.pdf page24

8 - Ministry of Power http://www.ambaccra.esteri.it/Ambasciata_Accra/resource/doc/2016/12/renewable_resources_and_potentials_20.12.2016.pdf

Tariff scheme

- **Retail price**[1] for end-users 18-20 US cents per kWh. There was a 59.2 % increase in electricity tariff in Dec 2015.
- **Prepayment exists**[2] (post-payment also exists)
- **Feed-In-Tarrif**[3]**:** Yes
- **Taxes**[4]**:** Solar systems are exempted from VAT if the components are brought in as units. However, if batteries and inverters are brought in separately, they are subject to VAT.

Sources:

1- ECG Billing Information http://www.ecgonline.info/images/publication/Bill.pdf,

2- Energy Outlook for Ghana 2017,

3- PURC http://purc.com.gh/purc/sites/default/files/fit_2016.pdf

4- IRENA Renewables Readiness Assessment page 23

Noteworthy programme or political will regarding RE and EE

National Energy Policy: 10% ENR (other than hydro) by 2020 *(Source: Ministry of Power)* - The current share of biomass and solar in electricity consumption is below 2% *(Source: 2017 Solar Fact and Figures Africa report by Solar Plaza page 29).*

Moreover, there is a strategy plan called Ghanaian Strategic National Energy Plan (SNEP) aiming at increasing generation capacity from 2.6 GW in 2012 to 5.5 GW by 2026 *(Source: PV Magazine: https://www.pv-magazine.com/2017/12/18/ghana-to-launch-rooftop-solar-program-in-2018/)*

Additional sources

➔ http://www.statsghana.gov.gh/

➔ IRENA. Ghana Renewables Readiness Assessment, 2015 [online] http://www.irena.org/DocumentDownloads/Publications/IRENA_RRA_Ghana_Nov_2015.pdf

PVPS Study "Net metering and PV self-consumption in emerging countries"
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INDIA

Net metering

- **Net metering is allowed depending on federal States' regulations**
- **Each State sets its own regulation.** There is a strong willingness for solar rooftop development: 2022 target is 40GW solar rooftop installed capacity, but only 3% of the target has been met because (among others) the development of residential prosumer activities is slower than planned.
- **Max. size of PV system** depending on federal States' regulations. Limitations can (i) apply at transformer level, (ii) be based on annual PV electricity import from consumers to the grid.
- **Compensation scheme** varies per federal State
- **Drivers:** Net metering is a booster of solar rooftop development as some of the generated rooftop solar power would be lost in the absence of net metering. But solar rooftops mainly concern commercial and industrial (C&I) users. Reasons:
  (i) **Grid retail price increase** was dramatic for C&I users (+22% in 5 years)
  (ii) **Solar energy is among the cheapest** in the world (0.67USD /W for system sizes over 10kW), if grid connected
  (iii) **There are commercial offers** for professional customers (while there is almost no offer targeting the residential users' segment)
- **Incentives to help customers to invest in PV**: some States set up incentives such as exemption from certain taxes.

Sources:

1- Bloomberg New Energy Finance. 2017. "Accelerating India Clean Energy Transition - The future of rooftop PV and other distributed energy markets in India. [online] https://data.bloomberglp.com/professional/sites/10/BNEF_Accelerating-Indias-Clean-Energy-Transition_Nov-2017.pdf

2- Bridge To India. India Solar Rooftop Map 2017. [online] http://www.bridgetoindia.com/reports/india-solar-map-september-2017/

Grid configuration and energy sector

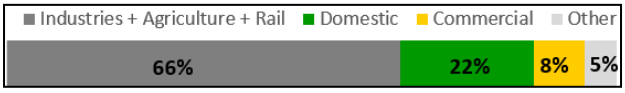
Ministry	Ministry of New & Renewable Energy (MNRE)
Regulators	States Electricity Regulatory Commissions (SERC) + Central Electricity Regulatory Commission (CERC)
Transmission	Powergrid Corporation of India Limited (POWERGRID), a Central Transmission Utility (CTU), is responsible for planning inter-state transmission system (ISTS). Similarly there are State Transmission Utilities (STU) (namely State Transco/ SEBs) responsible for the development of Intra State Transmission System. (Source: https://powermin.nic.in/en/content/overview-0)
Generation	n/a
Distribution	state-owned discoms, privately owned discoms and distribution franchisees
Others	► CEA (Government advisor on Energy aspects, specifies standards for energy connections) ► The Bureau of Energy Efficiency promotes and coordinates Energy Efficiency Programs in India https://beeindia.gov.in/ ► The National Solar Mission is a major initiative taken by the Ministry of New and Renewable Energy (MNRE), Government of India, in coordination with all the State Nodal Agencies (SNAs) to promote ecologically sustainable growth ► The Indian Renewable Energy Development Agency (IREDA) is a Non-Banking Financial Institution under the administrative control of this Ministry for providing term loans for renewable energy and energy efficiency projects. (http://www.ireda.gov.in/).

Urban sector facts & figures and residential customers

- **Main cities in 2011** *(Source: https://www.census2011.co.in/city.php)*
  ① Mumbai 12 442 373 inhabitants
  ② Delhi 11 034 555 inhabitants
  ③ Bangalore 8 499 399 inhabitants
- **Total population (2017)** 1,339.2 million (2017) (FNUAP http://www.unfpa.org/fr/data/world-population/IN)
- **Percentage of urban population (2016)** 33.1% (Source World Bank)

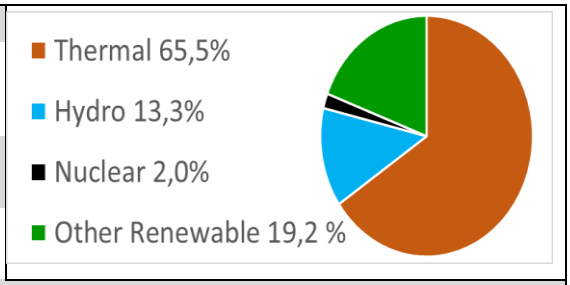
- **Urban average growth rate (2006-2016)** +1.14%/year (Source World Bank)
- **Forecast / Trends about residential customers:** n/a
- **Energy usage breakdown (2012):**

(Energy Statistics 2014, Central Statistics Office https://data.gov.in)



Electricity sector facts& figures

Installed capacity[1]	340 GW (04-2017) see energy mix
Evolution of peak power demand[2] (2009-2016)	+4%/year in average
Dependence on energy imports[3]	34% of energy used is imported
Supply VS Demand[4]	Peak Demand is not met (data from 2009 to March 2018)
Losses[5]	15 to 39% across Utilities
Blackouts[6]	n/a
Efficiency and financial soundness of Utility[7]	n/a
Solar potential[8]	about 5 kWh/m² /day



Source:

1 – https://powermin.nic.in/en/content/power-sector-glance-all-india
2 - CEA, https://powermin.nic.in/en/content/power-sector-glance-all-india
3 - https://data.worldbank.org/indicator/EG.IMP.CONS.ZS?locations=IN
4 - CEA, https://powermin.nic.in/en/content/power-sector-glance-all-india
5http://www.ifc.org/wps/wcm/connect/8bb2a280479cb7248b0fff299ede9589/Harnessing+Energy+From+The+Sun_Final.pdf?MOD=AJPERES page 39
8 - http://wgbis.ces.iisc.ernet.in/energy/paper/hotspots_solar_potential/results.htm

Tariff scheme

- **Retail price**[1] 0.04-0.09 USD/kWh for residential customers while 0.09-0.16 USD/kWh commercial customers (2017)
- **Prepayment is about to be implemented** [2]
- **Feed-In-Tariff** depends on the federal state's regulations
- **Taxes**[4]: No duty tax for imports but it may change to 7.5% duty tax on imports

Sources:

1 – *Bloomberg New Energy Finance. 2017.* Report mentioned in "Net Metering" Section. Page 11
2- https://timesofindia.indiatimes.com/city/thiruvananthapuram/get-ready-for-pre-paid-electricity-meters/articleshow/60230523.cms
4 - *https://www.bloomberg.com/news/articles/2018-01-04/india-is-said-to-consider-7-5-tariff-on-imported-solar-panels*

Noteworthy programme or political will regarding RE and EE

The Government of India has set a target of 175 GW renewable power installed capacity by the end of 2022. This includes 60 GW from wind power, 100 GW from solar power, 10 GW from biomass power and 5 GW from small hydro power. The target will mostly comprise 40 GW Rooftop and 60 GW through large and medium scale grid connected Solar Power Projects.

(Source: Central Electricity Regulatory Commission http://www.cercind.gov.in/2017/annual_report/AR1516E.pdf)

Additional sources

➔ Statistics: http://censusindia.gov.in/
➔ Annual reports of Central Electricity Regulatory Commission (English or Hindi) available on http://www.cercind.gov.in/annual_report.html
➔ Benchmark of solar cost 2017 released by the Central Electricity Regulatory Commission, March 2016 http://www.cercind.gov.in/2016/orders/SO17.pdf

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KENYA

Net metering

- **Net metering is not allowed.**
- **Regulations are under discussion since 2015**.
- Max. size of PV system
- Compensation
- Drivers
- **Incentives to help customers to invest in PV**: Exemption of VAT and duty import tax since 2013

Sources: IED

Grid configuration and energy sector

- **Electricity network is made up of national grid and mini-grids**

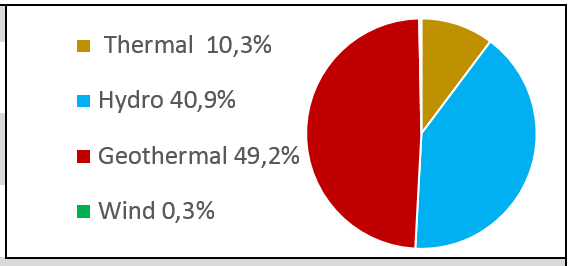
Ministry	Ministry of Energy and Petroleum
Regulators	ERC (Energy Regulatory Commission)
Transmission	Kenya Power (while construction of new infrastructures is the role of KETRACO)
Generation	► Geothermal Development Company (GDC) is in charge of geothermal power generation (surface exploration and drilling for steam) – founded in 2006 ► Kenya Electricity Generating Company (KENGEN) is the leading electric power generation company in Kenya, producing about 75 percent of electricity capacity installed in the country – founded in 1998 ► Independent Power Producers
Distribution	KENYA POWER (+ private distribution companies allowed under new energy bill)
Others	► REA Rural Electrification Authority founded in 2007 Expands rural electrification through connecting public facilities and surrounding "last mile" homes ► The Institute of Energy Studies and Research (IESR) is a Regional Centre of Excellence in Energy Training and Capacity Building. The institute offers professional courses to corporate organizations, private companies and contractors in the fields of energy, electrical, mechanical, fiber optics and management. The Institute also offers tailor made courses in any topic within these fields.

Urban sector facts & figures and residential customers

- **Main cities** (Source: *https://www.citypopulation.de/Kenya-Cities.html?cityid=332)*
  ① Nairobi : 3 133 518 inhabitants (2009)
  ② Mombasa : 915 101 inhabitants (2009)
  ③ Nakuru: 289 411 inhabitants (2009) (nowadays Kisumu is number 3)
- **Total population (2017)** 49.7 million *(Source : https://www.unfpa.org/fr/data/world-population-dashboard)*
- **Percentage of urban population (2016)** 26%
- **Urban average growth rate (2006-2016)** +1.69%/year (Source: World Bank)
- **Forecast / Trends about residential customers:** residential sales growth rate in 2016/2017 was of +6.5% *(Source: KPLC 2016 Annual Report page 43)*
- **Energy usage breakdown:** n/a

Electricity sector facts& figures

Installed capacity[1]	2295 MW (2016) - see energy mix :
Evolution of peak power demand[2] (2012-2016)	Average growth rate +5%/year
Dependence on energy imports[3]	Low (1.7% in 2017) mostly from Uganda
Supply VS Demand[4]	Demand < Production
Losses[5]	Technical losses: 18.9% of sales (2016)
Blackouts[6]	SAIFI 3.78 (2016) CAIDI 5.66 hours (2016)
Efficiency and financial soundness of Utility[7]	Good (2016)
Solar potential[8]	4-6kWh/m2/day



Source:

1 - USAID 2016 (https://www.usaid.gov/sites/default/files/documents/1860/Kenya_Power_Sector_report.pdf page 6) + KPCL Annual Report 2016/2017
2 - KPCL Annual Report 2016/2017 page 42
3 - KPCL Annual Report 2016/2017
4 - KPCL Annual Report 2016/2017 page 42
5 - KPLC Annual Report 2016/2017 page 4
6 - KPLC Annual Report 2016/2017 page 46
7 - KPLC Annual Report 2016/2017 page 4
8 - PVGIS

Tariff scheme

- **Retail price**[1]

For domestic segment (240V) in 2016		For small commercial (240V) in 2016
Fixed charged 1.19USD +		Fixed charged 150 KES (1.485 USD) +
If <50kWh	Energy charge 0.02USD/kWh	Energy charge from 0.13 USD per kWh
If <1500kWh	Energy charge 0.13USD/kWh	(There are off-peak rates for commercial clients)
If > 1500kWh	Energy charge 0.21UDSD/kWh	

- **Prepayment exists**[1] (65% of end-users are under prepayment scheme)
- **Feed-In-Tariff: Yes**
- **Taxes**[2]**:** Exemption of duty import tax for solar products

Source:

1 - KPLC website: http://kplc.co.ke/img/full/zcaJOzy5QmNN_Schedule%20of%20Tariffs%202013.pdf
2 - global-climatescope.org/en/policies/#/policiy/3887+ R. Boampong, M.A. Phillips. Renewable energy incentives in Kenya http://warrington.ufl.edu/centers/purc/purcdocs/papers/1610_Boampong_Renewable%20energy%20incentives%20in%20Kenya.pdf , pags 6 and 7 (2016)

Noteworthy programme or political will regarding RE and EE

Kenya has developed strategies to promote the use of renewable energy: the strategies are as set in the Least Cost Power Development Plan (LCPDP), Rural Electrification Master Plan, Sessional Paper No. 4 of 2004 (The energy policy document), the Energy Act of 2006, the Feed-in Tariff (FiT) Policy, the Kenya National Climate Change Response Strategy and Kenya Vision 2030 (the National economic development blueprint).

Source: IED and SCALING-UP RENEWABLE ENERGY PROGRAM (SREP) 2011
ERC website : https://erc.go.ke/index.php?option=com_content&view=article&id=148&Itemid=637

Additional sources

➔ Statistics: https://www.knbs.or.ke/publications/
➔ Utility annual report: http://kplc.co.ke/category/view/39/annual-reports

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PHILIPPINES

Net metering

● **Net metering is allowed.** As per December 2017, the 27 distribution companies (Discom) are dealing with customers under net metering contracts. This represents a total capacity of 9 583 kWp[1] and 1 329 clients[1].
● **Regulation applies since 2013**.
● **Max. size of PV system: 100 kWp. The customer has to be a net importer on a yearly basis.** Technical guidelines are available online, along with lists of installer companies and financial institutions, and document templates (see https://www.doe.gov.ph/net-metering-home)
● **Compensation is equal to production cost**, which varies per discom. For example, for MERLACO company, a residential customer (100kWh/month) pays 0.16 USD/kWh and gets 0.09 USD credit for every kWh he/she injects into the grid[2].
● **Drivers** Renewable Portfolio Standards that discoms have to comply with, according to "Renewable Energy Act" (2009). The target is 1% of sold electricity must be from renewable source by 2020[2] .
● **Incentives to help customers to invest in PV**: tax exemption

Sources:
1- Jayson G. Corpuz, National Electrification Administration (NEA)
2- GIZ, Ferdinand Larona

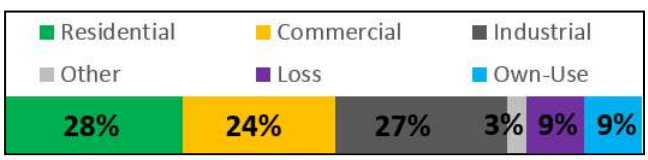
Grid configuration and energy sector

● **3 independent networks (Luzon / Vasayas / Mindanao) + several "small" independent grids**

Ministry	Department of Energy
Regulators	Energy Regulatory Commission (ERC).
Transmission	National Grid Corporation of the Philippines (NGCP): NGCP is a privately-owned corporation in charge of operating, maintaining, and developing the country's state-owned power grid, an interconnected system that transmits gigawatts hours of electricity at thousands of volts from where it is produced to where it is needed. NGCP also owns some power plants.
Generation	Private companies: financing power plants as IPP.
Distribution	27 privates companies
Others	RESA (Retail Electricity Suppliers Association) non-profit and non-governmental organization that caters to the needs of suppliers, end users and other players in the Philippine power industry.

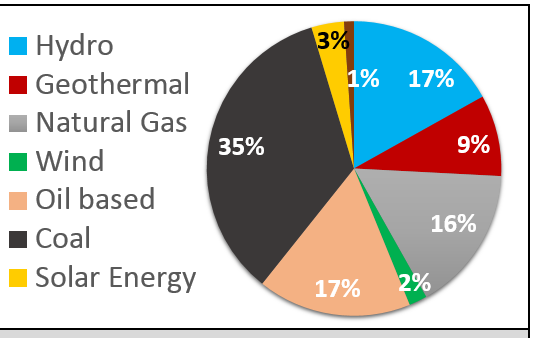
Urban sector facts & figures and residential sectors

● **Main cities** *(Source: https://www.citypopulation.de/)*
① Manilla: about 23 371 000 inhabitants (2015)
② Cebu: about 2 476 708 inhabitants (2015)
③ Davao: about 1 439 598 inhabitants (2015)
● **Total population (2017)** 104,9 million *(Source: https://www.unfpa.org)*
● **Percentage of urban population (2016)** 44.2% *(Source World Bank)*
● **Urban average growth rate (2006-2016)** -0,5% *(Source World Bank)*
● **Forecast / Trends** : "The demand increase is primarily driven by the growth of residential consumption at 12.7% from 22,747,049 MWh (2015) to 25,631,254 MWh (2016) due to high requirements for cooling system" *(Source : Philippine Power Situation Report 2016 (https://www.doe.gov.ph/electric-power/2016-philippine-power-situation-report))*
● **Energy production breakdown (2016)** *(Source: 2016 Philippine Power Situation Report p5)*



Electricity sector facts& figures

Installed capacity[1]	21,423 MW (2016) see energy mix
Evolution of peak power demand[2] **(2000-2016)**	Luzon: from 5 450 to 9 726 MW Visayas: from 749 to 17 893 MW Mindanao: from 939 to 1 653 MW
Dependence on energy imports[3]	44.7 % of electrical needs are imported as of 2017
Supply VS Demand[4]	Production < Demand
Losses[5]	7,9% of total sales in Luzon 11,8% of total sales Visayas ➔ OR 9% of the grand total sold 13,7% of total sales Mindanao
Existing blackouts[6]	Yes. There is a programme called Interruptible Load Program that helps to mitigate the energy deficiency until new capacities become available. Companies that take part agree to rely on their own production capacities (instead of the grid) during given periods of given days. Compagnies are compensated for their actual variable charges incurred (i.e., fuel cost) plus a certain margin, as will be agreed upon by the participating company and the Distribution Utility (DU).
Efficiency and financial health of Utility[7]	n/a
Solar potential[8]	4.5 to 5.5 kWh / m²/ day



Source:

1 - Power Situation Report 2016 (https://www.doe.gov.ph/electric-power/2016-philippine-power-situation-report)
2- https://www.doe.gov.ph/sites/default/files/pdf/energy_statistics/annual_system_peak_demand_per_grid_2016.pdf
3- from a presentation given in December 2017 by DOE Director Patrick Aquino
4- https://ph.ambafrance.org/Les-enjeux-de-l-energie-aux-Philippines-des-opportunites-pour-les-entreprises
5- idem 1
6- DOE website 2017 + https://www.resaph.com/programs/

Tariff scheme

- **Retail price** for end-users varies according to networks (see opposite table).
- **Prepayment exists** (both off line with vending system and online meters)
- **Feed-In-Tariff: Yes** for IPPs connected to the grid only.
- **Taxes:** 12% VAT applies on PV equipment imports, no customs duties.

Source : *https://www.napocor.gov.ph/index.php/2013-09-13-01-23-51/psalm-effective-rates*
And RE Law of 2008 (Republic Act. No. 9513)

Luzon	4,3893 P/kWh
Visayas	3,7432P/kWh
Mindanao	2,8459P/kWh

Residential end-users prices

Noteworthy programme or political will regarding RE and EE

National Energy Efficiency and Conservation Program, which is an action plan aiming at an annual reduction of 12% in oil importations and forex savings of $784Mn and to achieve an average annual 5,086 Gg CO2 equivalent emissions avoidance.

Additional sources

➔ https://www.doe.gov.ph/net-metering-home ➔ http://psa.gov.ph/

➔ MPE Engineering – Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). **DISTRIBUTION IMPACT STUDY GUIDELINES**. Guidelines to Study the Impact of Rooftop PV Systems on Distribution Networks in the Philippines.

➔ MPE Engineering – Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). **MANUAL FORM INTERCONNEXION**. Report to support the interconnection of rooftop-PV systems in the Philippines

➔ Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). **NET METERING REFERENCE GUIDE**. How to avail solar roof tops and other renewables below 100kW in the Philippines.

PVPS Study "Net metering and PV self-consumption in emerging countries"
conducted by IED in the frame of an IEA collaborative technical research programme

SOUTH AFRICA

Net metering

- **Net metering is allowed depending on municipalities' willingness (the latter are in charge of distribution)**
- **No national regulations, but a guideline exists since 2011: "Standard conditions for Small-Scale (<100kW) embedded generation".** Every municipality is free to allow net metering or not, and to put into force its own compensation schemes. Waiting for a national framework to apply, numerous documents[1] are available to help municipalities to set up their own business model. GIZ assisted in design of a tariff scheme modelling.
- **Max. size of PV system** 100 kWp
- **Compensation[2] scheme** varies per municipality (approvals from the regulators + yearly revisions).

Distribution entity	Retail price (2015)	Compensation value (2015)
e Thekwini	115.3Rand/kWh (excl.VAT)	74.96Rand/kWh (i.e. 65% of retail price)
Nelson Mandela Bay	from 78.3 to 157.9c/kWh (incl.VAT)	equal to retail price + service charge*

*Only clients over 950kWh/month are requested to pay 323.37R/month as service charge

- **Drivers[2]**

  (i) To increase the generation capacity: In 2007, demand exceeded supply. A pilot study was conducted in 2008. Then, in 2011, the guidelines were published. First system was installed in March 2013.

  (ii) To regulate illegal systems that appeared since solar production equipment became affordable and electricity tariffs increased

- **Incentives to help customers to invest in PV[2]**: Depending on each municipality. In fact, customers are requested to pay for procurement and installation of a bi-directional meter (190USD for a one-phase-meter/modem or 365USD for a three-phase-meter/modem). They can get half price incentives.

Source:

1- http://pqrs.co.za/wp-content/uploads/2015/03/NRS-097-2-3-final-2014.pdf

2- ICLEI Embedded Energy Generation Experience Study Case 174 http://www.cityenergy.org.za/uploads/resource_317.pdf

Grid configuration and energy sector

- **Electricity network is made up of national grid and mini-grids**

Ministry	Department of Energy
Regulators	NERSA (National Energy Regulator of South Africa) established in 2005
Transmission	Eskom (national Utility), state owned company since 2002
Generation	Eskom, that produces more than 95% of the energy (IRENA, 2013) + IPPs (about 3,271 MW installed capacity in 2017 July)[1]
Distribution	About 180 distribution companies. Most of them are South African municipalities
Others	PV Green Card, association promoting PV energy SAPVIA, association assisting stakeholders in the field of PV energy

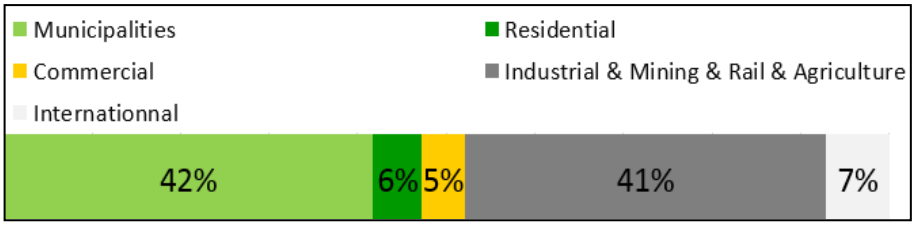
Source:

1- NERSA. Monitoring renewable energy performance of power plants. page 8
http://www.nersa.org.za/Admin/Document/Editor/file/Electricity/SustainableEnergy/Monitoring%20Report%20Oct2017_No2.pdf

Urban sector facts & figures and residential customers

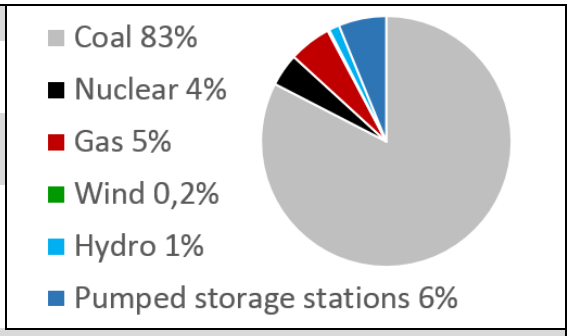
- **Main cities in 2011** *(Source http://www.citypopulation.de/SouthAfrica-UA.html)* ① Johannesburg 7 860 781 ② Cape Town 3 430 992 ③ Durban 2 786 046 inhab.
- **Total population (2017)** 51,8 million *(Oct 2011 Stats SA)*
- **Percentage of urban population (2016) 65,2%** *(Source World Bank)*
- **Urban average growth rate (2006-2016)** +0.8%/year *(Source World Bank)*
- **Forecast / Trends about residential customers:** n/a
- **Energy usage breakdown** (see next page):

(Eskom 2017 report p8)



Electricity sector facts& figures

Installed capacity[1]	44 134 MW (2017) see energy mix
Evolution of peak power demand[2] (2007-2016)	-0.67%/year on average
Dependence on energy imports[3]	Low
Supply VS Demand[4]	Supply meets Demand (it was not the case in 2007, but in the past decade power consumption declined on average by 0.5% a year)
Losses[5]	8.85% of total sales
Existing blackouts[6]	Interruption frequency (SAIFI) : 18.9 events / Interruption duration (SAIDI) 38.9hrs
Efficiency and financial health of Utility[7]	the Utility (Eskom): electricity revenue R 175.1 billion the Distribution Entities (Municipalities) municipal arrear debt: R9.4billion
Solar potential[8]	4.5 and 6.5 kWh/m² per day



Source:

1 – Eskom Integrated Report p5 http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf
2- Eskom Integrated Report p105 http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf
3- Eskom Integrated Report p6 http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf
4- Eskom Integrated Report p12 http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf
5- Eskom Integrated Report p41 http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf
6- Eskom Integrated Report p8-9 http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf
7- Eskom Integrated Report http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf
8- http://www.energy.gov.za/files/esources/renewables/r_solar.html

Tariff scheme

- **Retail price**[1] varies per municipality. See Net metering section for example. Average electricity price 83.6Rand/kWh
- **Prepayment exists** [2] since 1993.
- **Feed-In-Tariff**[3] named REFIT (Renewable Feed-In-Tariff) launched in 2009
- **Taxes**[4]: n/a

Sources:

1- *Eskom Integrated Report p8-9 http://www.eskom.co.za/IR2017/Documents/Eskom_integrated_report_2017.pdf*
2- STS Association http://www.sts.org.za/
3 -More details on:
http://www.energy.gov.za/files/esources/renewables/Department%20of%20Energy%20REFIT%20RFI%20for%20IPPs.%2027%20September%202010.pdf

Noteworthy programme or political will regarding RE and EE

n/a

Additional sources

➔ Statistics: http://www.statssa.gov.za/
➔ Policies: http://www.energy.gov.za/files/policies/p_electricity.html
➔ Information portal about sustainable development http://www.cityenergy.org.za/search.php

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