EL LEGAL AND REGULATORY INDICES SNAPSHOT: SSA Transmission Network Structures, Interconnections, and Grid Integration of Renewable Energy Source

Country	What is the structure of the Transmission grid and network?[1]	Is the grid receptive to RE sources? (yes/no)[2]	Are RE sources currently fed into the grid? (yes/no)[3]
Swaziland (Eswatini)	Country-scale transmission occurs via a 132 kV and 66 kV grid distributing to 11 kV lines, thus making its structure looped	Yes	Yes[4]
Senegal	There are two looped grid-systems: the 90 kV national grid and the 225 kV supranational grid, together totaling about 13,000 km.[5]	Yes	Yes[6]
Niger	In terms of technical characteristics, the transmission network of Niger is a loop system, however there are plans to upgrade the 66kV transmission line to a full 132 kV loop that connects four main high voltage and medium voltage substations supplying Niamey and the Western Grid.[7]	Yes	Yes[8]
Botswana	The electricity grid makes use of a loop network configuration which has different sources of electric power generation connected to the feeders, and they form a closed loop.[9]	Yes	Yes[10]
Zimbabwe	The electricity grid consists of a looped transmission network with 330 kV lines and one 400 kV line. The grid is notably interconnected with Mozambique, Zambia, Botswana, and South Africa.[11]	Yes	Yes[12]
Burkina Faso	The national network in Burkina Faso is interconnected.[13]	Yes	Yes[14]
Central African Republic	The electrical grid has both an interconnected and looped structure. It is made up of two lines making it possible to evacuate the energy produced by each plant with the possibility of postponing transit from one plant to another subject to certain constraints; two production source stations known as evacuations or elevators connecting the production units to the lines; two source distribution stations known as step-down stations for supplying the distribution network; and a line interconnecting the two distribution source substations.[15]	Yes	Yes[16]
Guinea	The electrical grid has an interconnected structure and is made up of high voltage transmission lines, interconnection stations and substations.[17]	Yes	Yes[18]
Malawi	The transmission lines total route length is 2,395 km of which 1121 km are operated at 66 kV and 1274 km are operated at 132 kV. The lines are constructed on both wood structures and steel structures. These lines in its looped structure, transmit bulk power at 66, 000 volts and 132, 000 volts, and feed power to over 70 transformers which are located at 39 substations in the country. [19]	Yes	Yes[20]
Mali	There is an interconnected transmission grid and distribution network with grid voltages ranging from 30kV to 225 kV[21]	Yes	Yes[22]
Uganda	The transmission grid is interconnected in structure and comprises High Voltage lines.[23] There are 108 substations with different transmission voltage ratings throughout the country, with Kawanda, Kiba, Oriang, Ayago and Karuma (under construction) having 400 kV transmission lines.	Yes	Yes[24]
South Africa	The transmission lines are looped and currently aggregated within each region of the State to increase transmission efficiency.[25]	Yes	Yes[26]
Benin	The simple radial network is an accurate representation of rural networks in Benin. However, a radial network is a poor representation of the distribution network in larger urban areas, where loop configurations are more prevalent.[27]	No	No[28]
Chad	The grid network in Chad which uses a radial network configuration for its transmission and distribution only covers one-third of the surface of N'Djamena, the capital. [29] This results in frequent outages. There is only one power source for a group of customers, and thus a power failure would interrupt power in the entire line which must be fixed before power can be restored.	No	No[30]
Comoros	Comoros' power system is radial, consisting of one subsystem for each of its three islands (Grand Comore, Anjouan and Moheli) without any interconnection between them.[31]	No	No[32]

Djibouti	The structure of the grid is radial as the distribution system comprises 20kV radial circuits emanating from the main substations in the country.[33]	**No**	**No[34]**
DRC	The network configuration employed in the transmission and distribution grid of DRC is radial and as such, there is a complete outage when one of the major feeders are disconnected.[35]	**No**	**No[36]**
Eritrea	The present electrical medium voltage distribution system in the country has primarily a radial structure. For conversion to a new voltage level of 15kv with minimal outages for the individual customers, the radial structure is not optimal, because a complete feeder, or major parts thereof have to be disconnected during the upgrading of the MV lines.[37]	**No**	**No[38]**
Gambia	Currently, the interconnected radial grid system is composed of low voltage in 0.4 kV and medium voltage (MV) in 11 and 33 kV with just 5 transformers. In addition, technical losses are mainly due to overloaded substations and a weak distribution network.[39]	**No**	**No[40]**
Mauritania	The transmission network of the electrical grid is radial and built around the main centers of demand.[41]	**No**	**No[42]**
Rwanda	The transmission network is composed of 30 sub-stations with both high and medium voltages, and it consists of radial or networked types.[43]	**No**	**No[44]**
Sao Tome and Principe	In terms of technical characteristics, the electricity transmission and distribution grid in São Tomé has an estimated radial network of 203 km of MV grid of 30 kV and 300 km of low voltage. The transmission and distribution of electricity in São Tomé and Príncipe is done on the same route, that is, the same medium voltage transmission grid serves as the distribution. In this case, electricity transmission and distribution are merged, and there are transforming stations in derivation in the transmission line, thus making the electricity system quite complex and the national electricity grid difficult to manage.[45]	**No**	**No[46]**
Sierra Leone	In terms of technical characteristics, the distribution networks in Sierra Leone, within Bo and Kenema are principally radial networks which emanate from a single substation in the centre of the city. Thus, the national grid is unable to meet electricity demand.[47]	**No**	**No[48]**
Somalia	In Somalia, the system of delivering electrical energy to users comprises a network of isolated distribution grids with isolated generation providers. These island networks are anchored to specific urban centres with dedicated electricity service providers. Each electricity service provider owns and operates their complete generation-distribution-customer-revenue chain using a radial distribution island network.[49]	**No**	**No[50]**
South Sudan	The electricity grid comprises of a radial electricity grid, commercial center networks in Juba, Malakal, and Wau; and rural mini grids in Yei, Kapoeta, and Maridi.[51]	**No**	**No[52]**
Togo	The transmission network is radial and comprises transmission lines ranging from 50 kV to 300 kV.[53]	**No**	**No[54]**
Cape Verde	In Cape Verde, some of the transmission/distribution systems on the islands in Cape Verde are radial, while the systems on the Maio and Fogo islands form a loop with increased reliability.[55]	**No**	**No[56]**
Equatorial Guinea	The Electricity Company of Equatorial Guinea (SEGESA) provides electricity, and it operates the country's two small electricity radial transmission networks, which comprise approximately 80 miles of high voltage lines.[57]	**No**	**No[58]**
Ethiopia	The transmission system features a radial network structure.[59] Overloading and failure of distribution lines owing to external pressures such as trees, animals, and wind cause power outages. Because there is no alternative electrical source when the radial distribution network fails, the whole power system network experiences a blackout.	**No**	**No[60]**
Gabon	In terms of technical characteristics, the transmission and distribution grid of Gabon operates a radial system.[61]	**No**	**No[62]**
Ghana	The transmission and distribution network has a radial network configuration. Thus, there are high loss rates in the country caused by long distances between power plants and customers.[63]	**No**	**No[64]**
Guinea-Bissau	The networks in Bissau are built in radial antenna structure and without backup.[65]	**No**	**No[66]**
Ivory Coast	The low voltage distribution network is a radial system. In the case of an overhead system, bare conductors were used previously, however, recently they are being replaced with covered conductors. The basic medium-voltage distribution system is implemented as the loop system or spindle system.[67]	**No**	**No[68]**
Lesotho	The transmission system configuration is a radial system, and it is fed from two generation stations and connected to South Africa at two supply points.[69]	**No**	**No[70]**
Liberia	The electricity grid is radial in structure,[71] and it serves less than one percent of the city's population.	**No**	**No[72]**
Madagascar	The electrical system of Madagascar consists of three interconnected radial networks which account for 70% of the total load of the country.[73]	**No**	**No[74]**
Mauritius	The transmission lines form a ring system and one radial feeder supplying the southern areas of the island.[75]	**No**	**No[76]**

Mozambique	The transmission system in Mozambique applies single radial configuration with three separate networks which cannot meet the required demand for electricity.[77]	**No**	**No**[78]
Namibia	The grid is mainly interconnected but also comprises single line radial feeds to help with continuity of supply while line breakers are maintained.[79]	**No**	**No**[80]
Zambia	The configuration of the electricity infrastructure in Eastern, Western, Southern and Northern provinces is radial.[81] Due to the radial nature of the network in the regions and the fact that power to the region is transmitted over a long distance, the regions usually suffer depressed voltage during peak periods.	**No**	**No**[82]
Nigeria	Nigeria operates a radial transmission network configuration. The radial network is unreliable, and it contributes to a high number of system collapses.[83]	**No**	**No**[84]
Republic of Congo	The network configuration for transmission and distribution grid is radial, however there are proposed projects to construct an electric loop in the country through the World Bank.[85]	**No**	**No**[86]
Seychelles	The Seychelles´ electricity grid also consists of two radial separated systems of 77 MW in Mahé and of 16 MW in Praslin and La Digue, respectively.[87]	**No**	**No**[88]
Sudan	The electricity grid comprises radial transmission and distribution lines ranging from 66 kV to 500 kV[89] which need extension and rehabilitation.[90]	**No**	**No**[91]
Tanzania	In Tanzania, power is distributed to the cities via a radial type system. The Tanzania power transmission network consists of 400 kV as the maximum voltage, with 220 kV, 132 kV and 66 kV following. Three Hydro power plants supply the power through 220 kV transmission lines to three directions: East west, North west, and South west.[92]	**No**	**No**[93]
Angola	Regarding the make-up of the electricity grid, Angola's transmission infrastructure is radial and made up of three separate major grid systems (northern, central, and southern), in addition to isolated grids in the east.[94]	**No**	**No**[95]
Burundi	Burundi operates a radial network configuration, and this has led to poor performances and the grid is unable to meet demand of rural areas.[96]	**No**	**No**[97]
Cameroon	The electrical system of Cameroon is made up of three separate (radial) but internally interconnected grids.[98]	**No**	**No**[99]
Kenya	In terms of technical characteristics of Kenya, the distribution network operates a radial distribution circuit. The distribution network has four bulk power sources feeding 66kV radial distribution lines which feed various load centres.[100]	**No**	**No**[101]

DISCLAIMER

The devised method of data representation and the mode of populating the figures and information in this snapshot document is not premised on and does not in any way imply the opinion of International Organizations, Ministries, Governmental Bodies and Regulatory Entities of SSA countries, relating to the legal status of the country, the territory, boundary, or delimitation of the country's frontiers.

Endnotes

1 The Radial system is used only when the substation or generating station is located at the center of the consumers. In this system, different feeders from a substation or a generating station and feed the distributors at one end. Thus, the main characteristic of a radial distribution system is that the power flow is in only one direction. It is the simplest system and has the lowest initial cost. Although this system is simplest and least expensive, it is not highly reliable. A major drawback of a radial distribution system is that a fault in the feeder will result in supply failure to associated consumers as there would not be any alternative feeder to feed distributors. On the other hand, similar level of system reliability to that of the parallel feeders can be achieved by using ring/loop distribution system. Here, each distribution transformer is fed with two feeders but in different paths. The feeders in this system form a loop which starts from the substation bus-bars, runs through the load area feeding distribution transformers and returns to the substation bus-bars. Moreover, loops are essential as they allow better management of the grid and therefore more reliability and an improved quality of service. Indeed, in case of a failure of the loop or a plant, the time and number of customers affected are minimized. The reason is that any substation located on the path of the loop may be fed from any production source in the system. This information is available at https://www.electricaleasy.com/2018/02/radial-parallel-ring-main-interconneted-distribution.html

It should be noted the reason for using the structure of the transmission network per country as a parameter, is because the integration of renewable energy into power grids requires a substantial transformation of the existing networks in to allow for a bi-directional flow of energy; establish an efficient electricity- demand and grid management mechanisms which is aimed at reducing peak loads; improving the interconnection of grids at the regional, national and international level; introducing technologies and procedures to ensure proper grid operation; and introducing energy storage capacity to store electricity from variable renewable sources when power supply exceeds demand. This information is obtained from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA-ETSAP_Tech_Brief_Power_Grid_Integration_2015.pdf

2 Based on research conducted by Electricity Lawyer regarding the Electricity Mix and Technical characteristics of SSA transmission grids, this snapshot concept has been developed to show the receptiveness of the existing network structures in SSA to renewable energy integration into their production and supply chain. Sources for this research can be found in our book 'Basics of Electricity Systems and Markets- Global insights, SSA realities', which is available to order here [link to e-store on the website].

3 It should be noted that the integration or receptiveness of RE sources into power grids would require a substantial transformation of the existing networks to allow for a bi-directional flow of energy and which is aimed at ensuring grid stability when installing distributed generation, as is done in a loop network configuration. Thus, only countries with looped network configurations can effectively allow RE sources to be fed into the grid. Furthermore, for radial system configurations to be receptive to RE sources, they need to undergo a network reconfiguration or an upgrade of the entire distribution system. This information is obtained from IEA-ETSAP IRENA (Technology Brief, 2015), "Renewable Energy Integration in Power Grids" available at https://www.irena.org/publications/2015/Apr/Renewable-energy-integration-in-power-grids

4 Information obtained from https://www.se4all-africa.org/seforall-in-africa/country-data/swaziland/

5 Energypedia, Senegal Energy Situation. Available at https://energypedia.info/wiki/Senegal_Energy_Situation

6 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20517/Energy_profile_Senegal.pdf?sequence=1&isAllowed=y

7 Ibid

8 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20521/Energy_profile_Niger.pdf?sequence=1&isAllowed=y

9 Loops are essential as they allow better management of the grid and therefore more reliability and an improved quality of service. Indeed, in case of a failure of the loop or a plant, the time and number of customers affected are minimized. Information obtained from https://www.bpc.bw/services-site/Documents/SRDS_contractors.pdf

10 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20482/Energy_profile_Botswana.pdf?sequence=1&isAllowed=y

11 USEA, Zimbabwe Power Sector. Available at https://usea.org/sites/default/files/event-/Zimbabwe%20Power%20Sector.pdf

12 Information obtained from https://www.africa-energy.com/article/zimbabwe-over-100mw-power-generation-be-added-national-grid-2021

13 Analysis of Burkina Faso Electricity System. Available at https://www.diva-portal.org/smash/get/diva2:1515684/FULLTEXT01.pdf

14 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20481/Energy_profile_Burkina.pdf?sequence=1&isAllowed=y

15 Available at http://enerca-rca.com/p/transport-enerca

16 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20497/Energy_profile_CentralAfricanRep.pdf?sequence=1&isAllowed=y

17 Available at https://edg.com.gn/transport-2/

18 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20508/Energy_profile_Guinea.pdf?sequence=1&isAllowed=y

19 ESCOM, Transmission. Available at http://www.escom.mw/transmission.php

20 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20501/Energy_profile_Malawi.pdf?sequence=1&isAllowed=y

21 IRENA, Renewables Readiness Assessment: Mali. Available at https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_RRA_Mali_2019_En.pdf

22 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20500/Energy_profile_Mali.pdf?sequence=1&isAllowed=y

23 Reconfiguration of Uganda's Bulk Network to Accommodate a Wholesale Electricity Market. September 2021. Available at http://www.scielo.org.za/pdf/arj/v112n3/03.pdf

24 Information obtained from https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Uganda_Africa_RE_SP.pdf

25 E. Chartan, et al, Preliminary Findings of the South Africa Power System Capacity Expansion and Operational Model Study. Available at https://www.nrel.gov/docs/fy18osti/70319.pdf

26 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20513/Energy_profile_SouthAfrica.pdf?sequence=1&isAllowed=y

27 Information obtained from https://www.mathematica.org/download-media?MediaItemId=%7B74EF3471-5CF0-4107-8693-8FE4F7D0ECA9%7D

28 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20483/Energy_profile_Benin.pdf?sequence=1&isAllowed=y

29 Information obtained from HYPERLINK "http://ir.jkuat.ac.ke/bitstream/handle/123456789/4016/Madjissembaye%20thesis_correction.pdf?sequence=1&isA Information obtained from HYPERLINK "https://wedocs.unep.org/bitstream/handle/20.500.11822/20482/Energy_profile_Botswana.pd

30 f?sequence=1&isAllowed=y" https://wedocs.unep.org/bitstream/handle/20.500.11822/20482/Energy_profile_Botswana.pdf?sequence=1&isAllowed=y
llowed=y" https://wedocs.unep.org/bitstream/handle/20.500.11822/20496/Energy_profile_Chad.pdf?sequence=1&isAllowed=y

31 Praene, Jean & Fakra, Damien & Bénard, Fiona & Ayagapin, Leslie. (2021). Comoros's energy review for promoting renewable energy sources. Renewable Energy. 10.1016/j.renene.2021.01.067.

32 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20495/Energy_profile_Comoros.pdf?sequence=1&isAllowed=y

33 Geothermal Development in Republic of Djibouti: A country update report available at http://theargeo.org/fullpapers/COUNTRY%20UPDATE%20REPORT%20FOR%20DJIBOUTI.pdf

34 Information obtained from HYPERLINK "https://wedocs.unep.org/bitstream/handle/20.500.11822/20491/Energy_profile_Djibouti.pdf?sequence=1&isAllowed=y"

35 https://weto_Interconnect_the_Power_Grids_of_the_Central_African_Republic_and_the_Democratic_Republic_of_Congo_from_the_Boali_Hydro-Power_System%E2%80%93Phase_1_-_Project_Appraisal_Report_.pdf

36 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20492/Energy_profile_DemocraticRepCongo.pdf?sequence=1&isAllowed=y

37 World Bank, available at https://documents1.worldbank.org/curated/en/148481468273355584/pdf/E18380v10EA0P11BLIC10AFR1EA1P110202.pdf

38 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20488/Energy_profile_Eritrea.pdf?sequence=1&isAllowed=y

39 Available at https://www.aijbm.com/wp-content/uploads/2020/10/K3108793.pdf

40 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20510/Energy_profile_Gambia.pdf?sequence=1&isAllowed=y

41 IRENA, Mauritania: Renewables Readiness Assessment. 2015. Available at https://www.irena.org/-/media/Files/IRENA/RRA/Country-Report/IRENA_RRA_Mauritania_EN_2015.pdf

42 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20499/Energy_profile_Mauritania.pdf?sequence=1&isAllowed=y

43 A radial feeder leaves the station and passes through the service area with no normal connection to any other supply. This type is common in long rural lines with isolated load areas. A networked system however, has multiple connections to other points of supply and it is found in more urban areas. These pints of connection allow various configurations by the operating utility through closing and opening of switches by a remote control or lineman. The benefit of the networked model is that in the event of a fault or required maintenance a small area of network can be isolated, and the remainder kept on supply

44 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20519/Energy_profile_Rwanda.pdf?sequence=1&isAllowed=y

45 ALER, available at https://www.aler-renovaveis.org/contents/files/aler-relatorio-stp-nov2020.pdf

46 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20518/Energy_profile_SaoTome.pdf?sequence=1&isAllowed=y

47 AfDB, available https://www.afdb.org/fr/documents/document/sierra-leone-rehabilitation-and-extension-bo-kenema-distribution-system-arap-summary-92616

48 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20515/Energy_profile_SierraLeone.pdf?sequence=1&isAllowed=y

49 MOP, available at https://mop.gov.so/wp-content/uploads/2019/12/NDP-9-2020-2024.pdf

50 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20514/Energy_profile_Somalia.pdf?sequence=1&isAllowed=y

51 South Sudan Oil & Power 2017 POWER SECTOR IN SOUTH SUDAN. Available at https://aop-media-serv-eu-1.s3.eu-central-1.amazonaws.com/2017/10/Energy-Ministry-presentation_FIN.pdf

52 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20597/Energy_profile_SouthSudan.pdf?sequence=1&isAllowed=y

53 Available at http://www.ecowrex.org/mapView/?mclayers=layerGridNetwork

54 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20593/Energy_profile_Togo.pdf?sequence=1&isAllowed=y

55 Ministry of Economy and Employment, The Study of Information Collection and Verification Survey for Renewable Energy Introduction and Grid Stabilization in T Information obtained from HYPERLINK "https://wedocs.unep.org/bitstream/handle/20.500.11822/20487/Energy_profile_Cameroon.pdf?sequence=1&isAllowed=y" https://wedocs.unep.org/bitstream/handle

56 /20.500.11822/20487/Energy_profile_Cameroon.pdf?sequence=1&isAllowed=y
am/handle/20.500.11822/20498/Energy_profile_Cape%20Verde.pdf?sequence=1&isAllowed=y" https://wedocs.unep.org/bitstream/handle/20.500.11822/20498/Energy_profile_Cape%20Verde.pdf?sequence=1&isAllowed=y

57 Ibid

58 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20489/Energy_profile_EquatorialGuinea.pdf?sequence=1&isAllowed=y

59 Due to the radial nature of the network in the regions and the fact that power to the region is transmitted over a long distance, the regions usually suffer depressed voltage during peak periods. There is also the problem of faulty electrical protection equipment such as circuit breakers and protection relays at most of the sites.

60 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20512/Energy_profile_Ethiopia.pdf?sequence=1&isAllowed=y

61 Information available at https://depot-e.uqtr.ca/id/eprint/7315/1/030621774.pdf

62 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20511/Energy_profile_Gabon.pdf?sequence=1&isAllowed=y

63 Information obtained from https://www.mathematica.org/download-media?MediaItemId=%7B74EF3471-5CF0-4107-8693-8FE4F7D0ECA9%7D

64 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20509/Energy_profile_Ghana.pdf?sequence=1&isAllowed=y

65 Ibid

66 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20507/Energy_profile_GuineaBissau.pdf?sequence=1&isAllowed=y

67 Information obtained from https://openjicareport.jica.go.jp/pdf/12361135_02.pdf

68 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20493/Energy_profile_CotedIvoire.pdf?sequence=1&isAllowed=y

69 A radial system has only one power source for a group of customers. A power failure, short-circuit, or a downed power line would interrupt power in the entire line which must be fixed before power can be restored.

70 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20505/Energy_profile_Lesotho.pdf?sequence=1&isAllowed=y

71 World Bank, LIBERIA Electricity System Enhancement Project (LESEP). March 2018. Available at https://documents1.worldbank.org/curated/en/204851522416201623/pdf/implementation-completion-and-results-report-icr-document-P120660-03272018.pdf

72 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20504/Energy_profile_Liberia.pdf?sequence=1&isAllowed=y

73 World Bank, available at https://documents1.worldbank.org/curated/en/107891468184443896/pdf/PAD1147-P151785-IDA-R2016-0023-1-OUO-9.pdf

74 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20502/Energy_profile_Madagascar.pdf?sequence=1&isAllowed=y

75 CEB, available https://ceb.mu/our-activities/transmission-and-distribution

76 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20525/Energy_profile_Mauritius.pdf?sequence=1&isAllowed=y

77 A radial system has only one power source for a group of customers. A power failure, short-circuit, or a downed power line would interrupt power in the entire line which must be fixed before power can be restored.

78 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20523/Energy_profile_Mozambique.pdf?sequence=1&isAllowed=y

79 Transmission Grid Code: Electricity Act, 2007. Available at https://www.lac.org.na/laws/2018/6731.pdf

80 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20522/Energy_profile_Namibia.pdf?sequence=1&isAllowed=y

81 Due to the radial nature of the network in the regions and the fact that power to the region is transmitted over a long distance, the regions usually suffer depressed voltage during peak periods. There is also the problem of faulty electrical protection equipment such as circuit breakers and protection relays at most of the sites.

82 Information obtained from https://www.unido.org/who-we-are/unido-worldwide/africa/selected-projects/zambia

83 Information obtained from https://energypedia.info/wiki/Nigeria_Energy_Situation

84 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20520/Energy_profile_Nigeria.pdf?sequence=1&isAllowed=y

85 Information obtained from https://documents1.worldbank.org/curated/en/980891468247276214/pdf/PAD9150PJPR0P1010Box385308B00OUO090.pdf

86 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20516/Energy_profile_Seychelles.pdf?sequence=1&isAllowed=y

87 Creating the enabling environment for Seychelles' 100% Renewable Energy Strategy (SeyRES 100), 2018. Available at https://www.greenclimate.fund/sites/default/files/document/19250-creating-enabling-environment-seychelles-100-renewable-energy-strategy-seyres-100.pdf

88 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20516/Energy_profile_Seychelles.pdf?sequence=1&isAllowed=y

89 Available at http://www.geni.org/globalenergy/library/national_energy_grid/sudan/sudanesenationalelectricitygrid.shtml

90 World Bank, Diagnostic Review of Sudan Electricity Sector. Available at https://openknowledge.worldbank.org/bitstream/handle/10986/33702/From-Subsidy-to-Sustainability-Diagnostic-Review-of-Sudan-Electricity-Sector.pdf?sequence=1

91 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20596/Energy_profile_Sudan.pdf?sequence=1&isAllowed=y

92 JICA, available at https://openjicareport.jica.go.jp/pdf/12288619.pdf

93 Information obtained from https://www.usaid.gov/powerafrica/tanzania

94 International Trade Administration, 'Angola – Country CommercialGuide'. Available at https://www.trade.gov/country-commercial-guides/angola-energy

95 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20484/Energy_profile_Angola.pdf?sequence=1&isAllowed=y

96 Information obtained from https://dial.uclouvain.be/downloader/downloader.php?pid=thesis%3A14683&datastream=PDF_01&cover=cover-mem

97 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20486/Energy_profile_Burundi.pdf?sequence=1&isAllowed=y

98 Evaluation of Rural Electrification Concessions in sub-Saharan Africa. Detailed Case Study: Cameroon. Available at https://documents1.worldbank.org/curated/en/361311498151364762/pdf/116642-WP-PUBLIC-P150241-20p-Detailed-Case-Study-Cameroon-20151204-No-Logo.pdf

99 Information obtained from https://wedocs.unep.org/bitstream/handle/20.500.11822/20487/Energy_profile_Cameroon.pdf?sequence=1&isAllowed=y

100 EPRA, available at https://www.epra.go.ke/wp-content/uploads/2021/05/Draft-Kenya-National-Distribution-Grid-Code-KNDGC-30-04-2021-2.pdf

101 Information available at https://wedocs.unep.org/bitstream/handle/20.500.11822/20506/Energy_profile_Kenya.pdf?sequence=1&isAllowed=y