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Assessing the Potential and Barriers of Renewable Energy Market in Developing Countries: The Case of Kenya

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Presentation Outline

- National Energy Context
- Business and operational environment
- Support mechanism for RES project
- Investment opportunities and potential barriers
- Energy policy and planning

State of Energy Affair in Kenya

- Kenya is located on the East coast of Africa
- High dependence traditional biomass
- Low access to modern energy services
- High cost of rural electrification through grid extension due to scattered nature of settlements.
- National electrification rate (2012): 23% [3]
  - Urban: 58.20%
  - Rural access: 6.70%
- KPLC achieved a 55% national connectivity rate in 2016. [4]
- Government driven strategy and policy:
  - A middle-income economy country by 2030 (Vision 2030)
  - Least Cost Power Development Plan (2011 – 2031)
  - Plan to replace the current FiT system with an auction model.
- Climate Action Plan:
  - Kenya's INDC set out a GHG emission reduction target of 30% by 2030. [11]

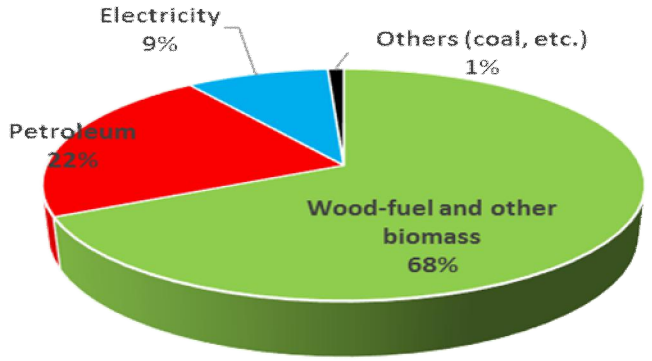


Figure 1: Primary Energy Supply in Kenya (2014) [2]

Table 1: Selected Energy Indicators of low and middle-income countries (IEA 2016) [1]

Indicator	Unit	Kenya (2014)	Morocco (2014)	South Africa (2014)
Population	Millions	44.86	33.92	54.00
GDP	Billion 2010 USD	49.40	108.39	411.04
Energy production	Mtoe	19.57	1.76	168.32
Net imports	Mtoe	4.60	19.53	-18.03
TPES	Mtoe	23.63	18.98	147.02
Electricity consumption	TWh	7.67	30.93	228.98
CO_2 emissions	Mt of CO_2	12.35	53.11	437.37
TPES/population	toe/capita	0.53	0.56	2.72
Electricity consumption/population	MWh/capita	0.17	0.91	4.24
CO_2/population	t CO_2/capita	0.28	1.57	8.10

Electricity Sector: Business and Operational Environment

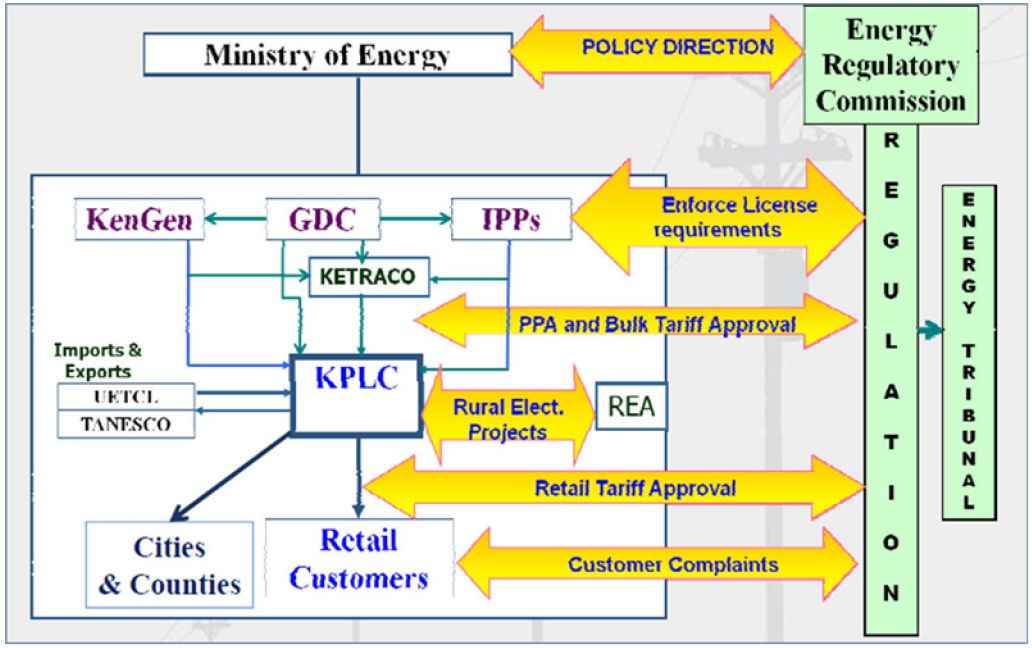


Figure 2: Electricity Market Structure. [12]

KenGen – Kenya Electricity Generating Company
GDC – Geothermal Development Company Ltd
IPPs – Independent Power Producers
KETRACO – Kenya Electricity Transmission Company Ltd
KPLC – Kenya Power and Lighting Company (Kenya Power)
REA – Rural Electrification Authority

- Kenya's electricity market is structured as a single buyer market
- KPLC purchases bulk power from the generators via PPAs approved by ERC for transmission, distribution and supply to the end-consumers.
- Member of the Eastern Africa Power pool (EAPP)

Electricity Demand and Supply

- Installed electricity generation capacity (June 2016): 2341 MW [5]
- Effective capacity: 2271 MW
- Peak Demand: 1586 MW
- Total Electricity production: 9.82 TWh
- Total Electricity consumption: 7.91 TWh

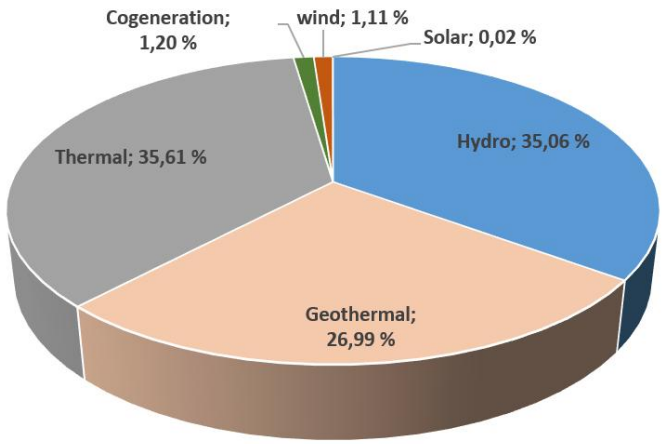


Figure 3: Current Electricity Generation by Source (June 2016) [5]

- Hydro power and geothermal are currently the leading renewable source of electricity.
- Demand for electricity is increasing faster than the ability to install additional generation capacity.
- Aim to expand installed capacity to about 6700 MW by 2017. [13]
- Droughts have recently affected the country and undermined its hydropower capacity.
- Estimated hydropower potential in the range of 3000-6000 MW. [7][8][9]
- Increasing share of geothermal energy

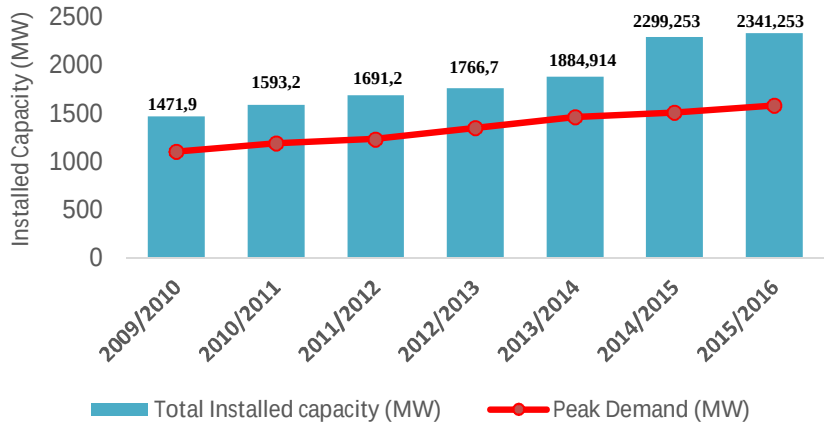


Figure 4: Installed Capacity and Peak Demand from 2010 – 2016. [6]

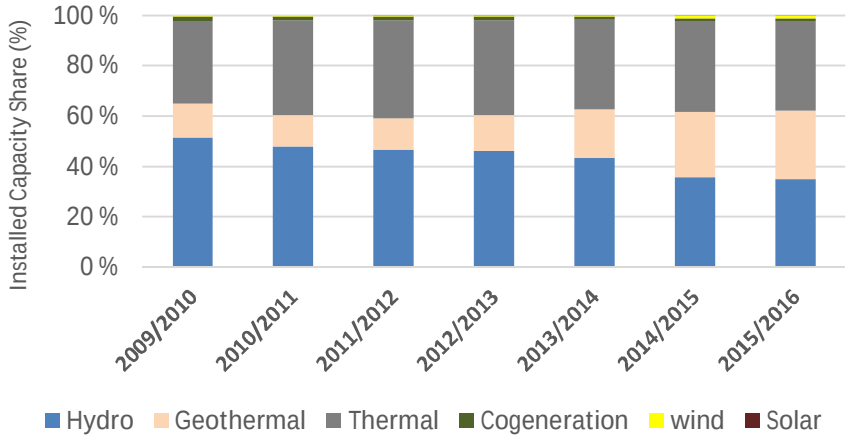


Figure 5: Trend Installed Electricity Generation Capacity by Source (2010 – 2016) [6]

The Actors in Kenya's Electricity Generation Market

Table 2: Current Electricity Generation Capacity in Kenya (June 2016) [5]

SOURCES	KENGEN (MW)	REP (MW)	IPP (MW)	EPP (MW)	TOTAL INSTALLED CAPACITY (MW)	CAPACITY SHARE (%)
Hydro	820		0,81		820,81	35,06 %
Geothermal	493		139		632	26,99 %
Thermal	263	18	522,82	30	833,82	35,61 %
Cogeneration			28		28	1,20 %
wind	25,5	0,55			26,05	1,11 %
Solar		0,57			0,57	0,02 %
Total (MW)	1601,5	19,12	690,63	30	2341,25	100,00 %
% Share	68,40 %	0,82 %	29,50 %	1,28 %	100,00 %	

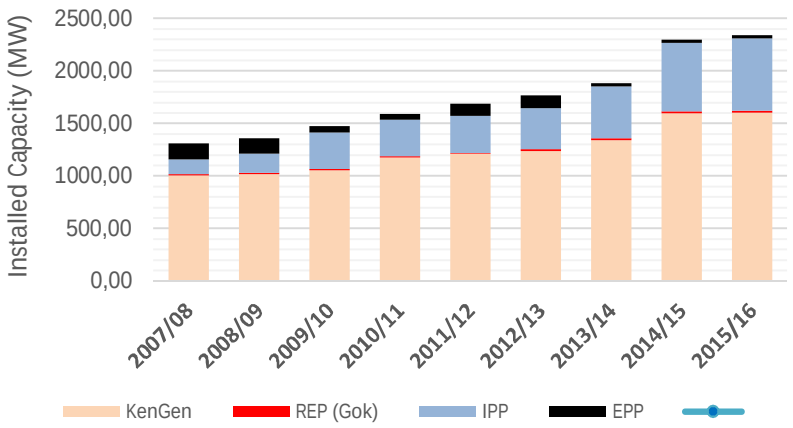


Figure 6: Contribution of the electricity generators in Kenya (2008 – 2016) [6]

- Kenya's energy generation market is liberalized
  - The Kenya Electricity Generating Company (KENGEN) presently generates about 68% of the total installed capacity.
  - The Independent Power Producers (IPPs) accounted for ~ 30% of the net electricity generation
  - Emergency Power Producer, EPP (Aggreko) was hired to produce backup supply as a result of low rainfall in parts of the country.
  - Increased IPPs has help reduce the dependent on the costly diesel-generated EPP from Kenya's energy mix.

- Existing private off-grid operators.
  - Powerhive (US based company) → first licensed (distribution license) private mini-grid operator.
  - Steamaco → Smart off-grid asset management.
  - PowerGen Renewable Energy

Figure 3: List of IPPS in Kenya (2016) [5]

IPPs	Source	Capacity (MW)
Iberafrica I&II	Thermal	108,5
Tsavo	Thermal	74
Thika Power	Thermal	87
Rabai Power	Thermal	90
Triumph Diesel	Thermal	83
Gulf Power	Thermal	80,32
OrPower 4 – plant I,II&III	Geothermal	110
OrPower 4 -(4th plant)	Geothermal	29
Mumias	Bagase cogeneration	26
Biojule Kenya Limited	Biogas-fired	2
Imenti Tea Factory (Feed-in Plant)	Small hydro	0,3
Gikira small hydro	Small hydro	0,514

Tariff-Based Support Mechanisms for RES Projects

Feed-in-Tariff (FiT)

- Current 20 year FiT levels categorized by project size, are shown below

Table 4: FiT values for RE projects with installed capacity up to 10 MW [9][10]

Technology	Installed Capacity (MW)	Standard FiT (US$/kWh)	% of FiT subject to escalable	Min. Capacity (MW)	Max Capacity (MW)
Wind	0.5 – 10	0.11	12%	0.5	10
Hydro	0.5	0.105	8%	0.5	10
	10	0.0825			
Biomass	0.5 – 10	0.10	15%	0.5	10
Biogas	0.2 – 10	0.10	15%	0.2	10
Solar (Grid)	0.5 – 10	0.12	8%	0.5	10
Solar (Off-Grid)	0.5 – 10	0.20	8%	0.5	10

Table 5: FiT values for RE projects above 10 MW with installed capacity [9][10]

Technology	Installed Capacity (MW)	Standard FiT (US$/kWh)	% of FiT subject to escalable	Min. Capacity (MW)	Max. Capacity (MW)	Max. Cumulative Capacity (MW)
Wind	10.1 – 50	0.11	12%	10.1	50	500
Geothermal	35 – 70	0.088	20% for first 12 years and 15% after	35	70	500
Hydro	10.1 – 20	0.0825	8%	10.1	20	200
Biomass	10.1 – 40	0.10	15%	10.1	40	200
Solar (Grid)	10.1 – 40	0.12	12%	10.1	40	100

A **competitive auction system** is expected to replace the FiT program soon [ERC].

- Drivers: to drive down the cost of electricity
- Experience in sub-Sahara Africa: Kenya want to follow the footsteps of Zambia which in June 2016 held Africa's inaugural solar auction that attracted rock bottom prices: US¢ 6.02/kWh for a 47.5 MW solar farm by NEOEN S.A.S. / First Solar Inc. and another US¢ 6.02/kWh for a 28MW plant by Enel as winners. [17]

In addition to the FIT scheme, other fiscal incentives for investors in the power sector include:

- Exclusion from payment of customs on equipment used in electricity generations stations.
- Exemptions from payment of VAT on equipment used in electricity generation stations.

Geothermal Energy Growth

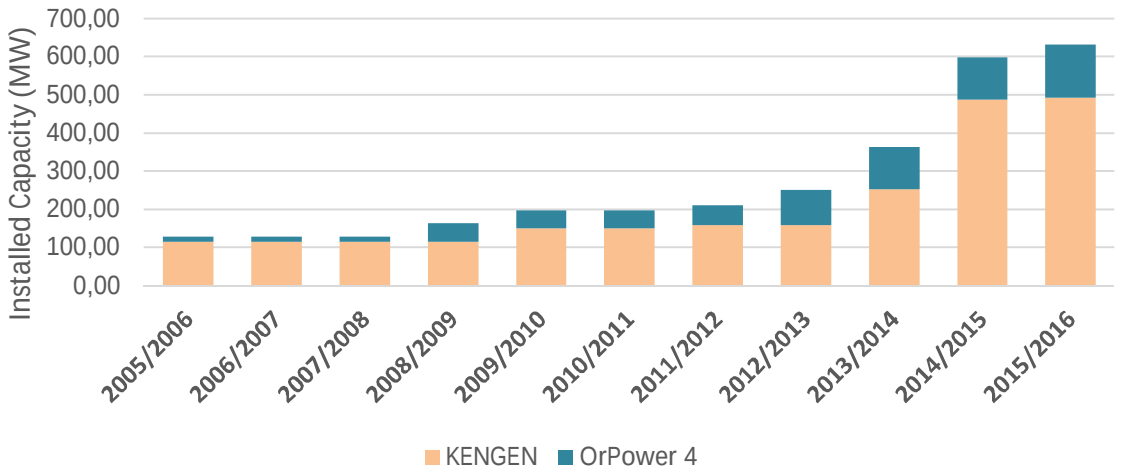
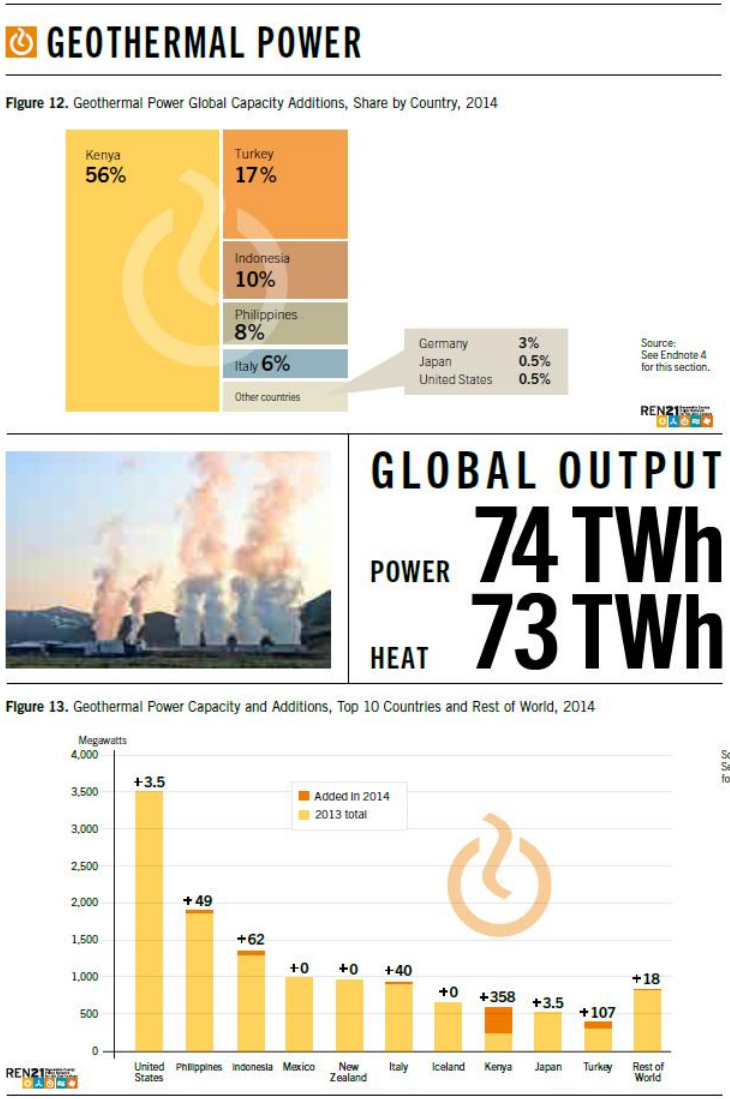


Figure 7: Geothermal Energy Evolution in Kenya from 2006 – 2016 [6]

- Accelerated deployment of geothermal resources over the last few years: KenGen taking the leading role.
- Ormat Technologies(OrPower): sole private investor in geothermal energy in Kenya so far.
- Estimated geothermal potential of 5000 MWe – 10000 MWe from high temperature resources in some inspected sites. [7][8][9]
- Kenya accounted for more than half of the 640 MW geothermal power capacity added worldwide in 2014. [14]
- Exploration risk mitigation remains a hurdle for geothermal development especially in developing countries.



Source: REN21. (2015). *RENEWABLES 2015 GLOBAL STATUS REPORT*

Wind Energy in Kenya

Wind Resource Potential

- Estimated wind speeds of 8 -14 m/s in certain part of Kenya. [7][8][9]

Ongoing Wind Power Project:

- The 310 MW Lake Turkana Wind Power project (356 V52-850 kW turbines)
  - Single largest private investment in Kenya's history (total project cost € 622 million)
  - Sponsors: KP&P Africa B.V and Aldwych International as co-developers, Investment Fund for Developing Countries, Vestas Eastern Africa Limited, Finnish Fund for Industrial Cooperation Ltd, KLP Norfund Investments AS and Sandpiper Limited.
  - The project is expected to be completed and injected to the national grid by June 2017.
  - The project will be injected to the national grid, and expect to produce 1440 GWh of electricity annually (about 15% of the current consumption)
  - Power produced will be bought at fixed price by KPLC over a 20-years period in accordance with the PPA signed with KPLC. [13]

Challenges:

- High capital investment for transmission lines due to wind power potential areas being far away from the grid and load centres.
- Recent projects have faced delays in form of local communities resistant.

Status of Solar Energy in Kenya

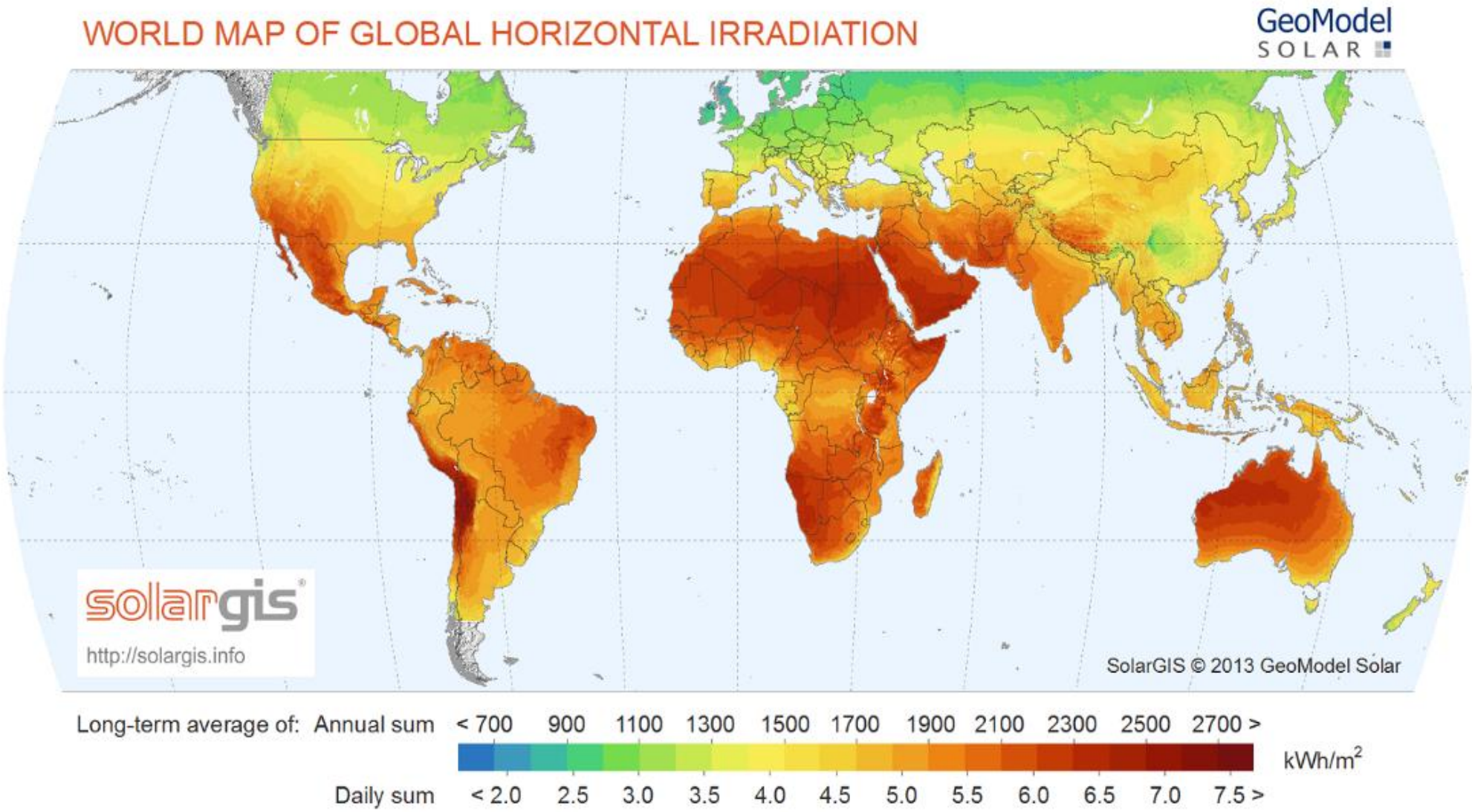
Solar Energy Resources Potential

- Daily solar radiation of 4 - 6 kWh/m2.
- Its annual average is about 5 kWh/m2/day, equivalent to 250 Mtoe (2907 TWh) per day. [7][8][9]

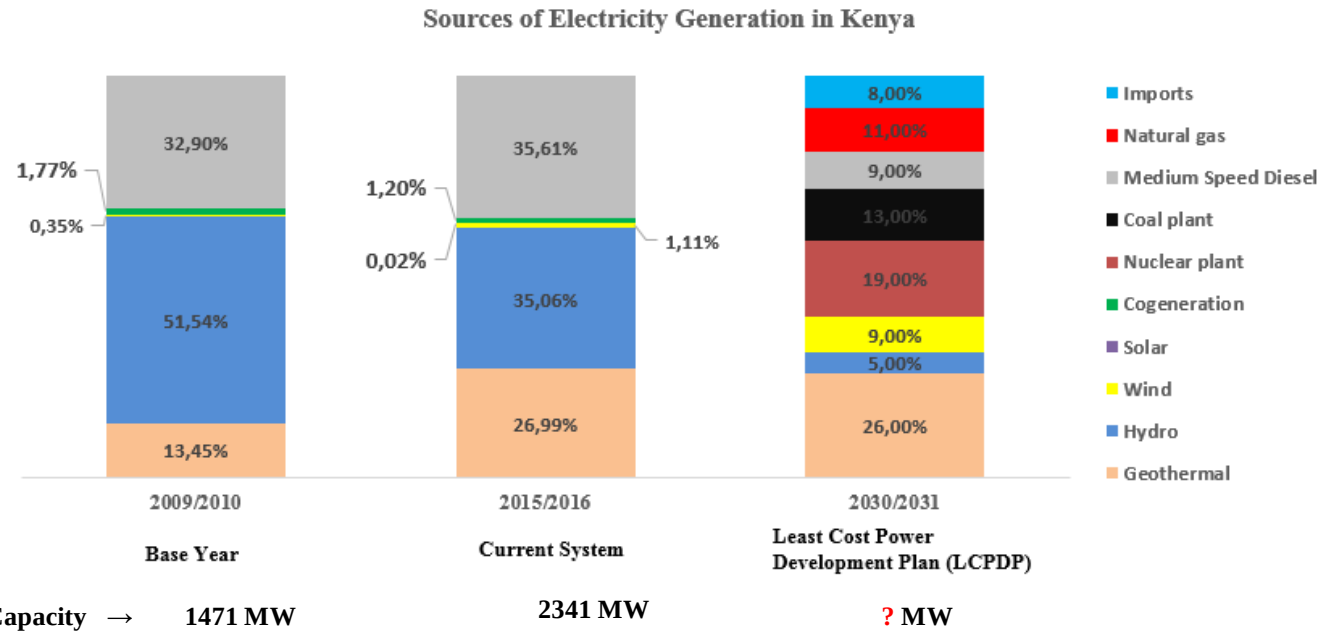
Solar Power Project:

- First solar system (600 kW project at Strathmore Business School in Nairobi) at with a PPA to supply electricity to the grid was realised in 2015.
- The GoK initiated a programme for electrification of institutions far from grid using solar PV systems.
- Proposed solar projects are: [15]
    - 55 MW solar power plant in Garissa by REA.
    - 40 MW Solar farm project (WITU) by Kenya Solar Energy limited.
    - Further solar plant each with a capacity of 40 MW different locations. [15]
- Challenges:
    - High upfront capital cost for plant and equipment.
    - Inadequate economies of solar technologies as expressed in the LCPDP.
    - Proliferation of sub-standard solar energy technologies and equipment.

Solar radiation



Energy policy and Planning



- The updated version of the LCPDP (2011- 2031) was released in March 2011 by ERC. [7]
- Electricity demand is forecasted to rise from 6683 GWh in 2010 to 61,490 GWh by 2031, annual increase of about 12%.
- Plan to add 5530 MW of geothermal resources to the energy mix by 2031.
- LCPDP establishes a ranking of base load and peak load sources on their expected LCOE.
- Two important observations can be made looking at the LCPDP
  - Fossil fuels are given prominent role
  - Solar energy technologies are not included in the power generation expansion plan for the studied period
- Reason why solar technologies were not considered among the candidate resources is not clearly stated in the document
- However, it appears that solar PV and CSP were implicitly drop due to their high perceived cost compared to the alternatives.
- The energy planners consider them unattractive options after the 8% discount rate used throughout the LCPDP [16].

Conclusion: Investment Opportunities in Power Sector

- Kenya's electricity market provides a sound enabling environment for investment.
- The market is open to private sector investments from both local sources and foreign source of capital, and has developed a number of policies aimed at attracting foreign capital.
- The Public Private Partnership (PPP) act of 2013 was developed to support investment under PPP. [18]
- Given that majority of the population is not yet connected to the national grid, and the electricity demand is forecast to grow annually by 12% (from 6683 GWh in the 2010 to 61490 GWh by 2031). [7]
    - Private sector investment is necessary to deliver a substantial portion of the required electricity infrastructure.
    - Possibilities of renewable energy grid-connected generation options, especially wind and solar technologies.
- More than 80% of the rural population has no access to electricity
    - Potential size of off-grid solution, Solar Home System (SHS), Solar lantern
    - Rural electrification projects
- Promotion of energy efficiency and conservation initiatives
- GDC has removed upfront risks for investors by conducting infrastructural development, exploration and drilling of wells in the Rift Valley region. Therefore KenGen and private investor can compete for license to set up power plants at the site.

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