

GEOTHERMAL DEVELOPMENT IN KENYA: UPDATE AND THE ROLE OF UNU-GTP IN CAPACITY BUILDING

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OUTLINE

GEOTHERMAL ENERGY IN KENYA

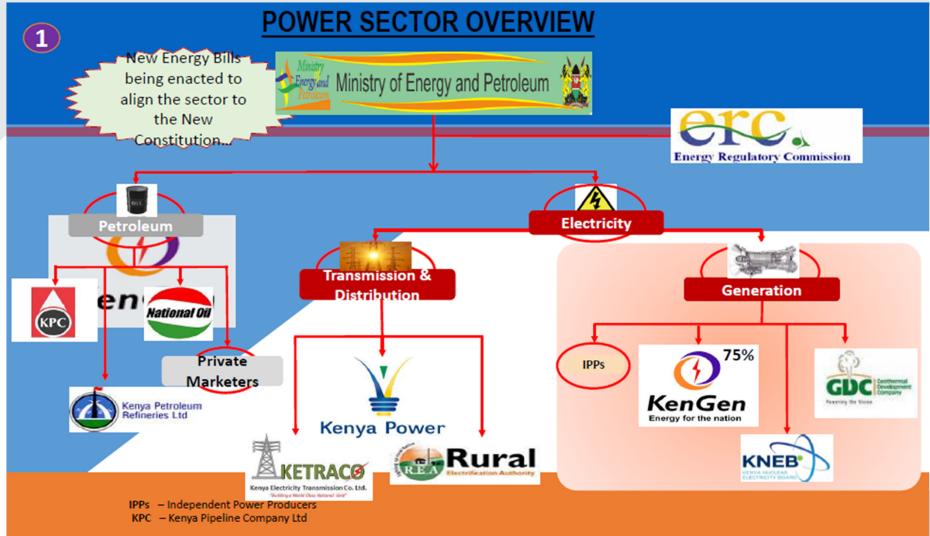
GEOTHERMAL DEVELOPMENT JOURNEY

GEOTHERMAL STATUS AND UPDATE

CAPACITY BUILDING BY UNU-GTP

CONCLUSION





KENYA'S POSITION IN TOP 10 GEOTHERMAL COUNTRIES

TOP 10 GEOTHERMAL COUNTRIES

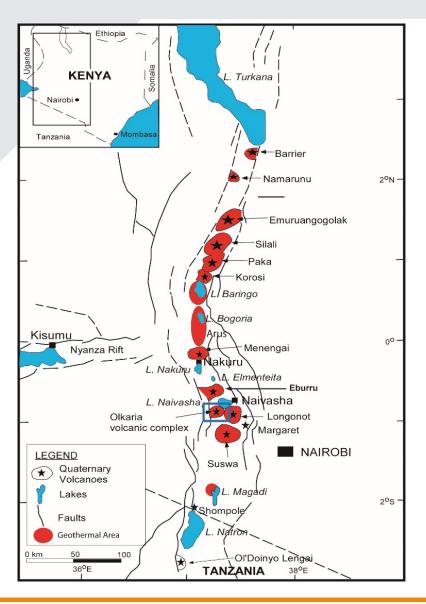
INSTALLED CAPACITY - MW (JANUARY 2018) - 14,060 MW IN TOTAL





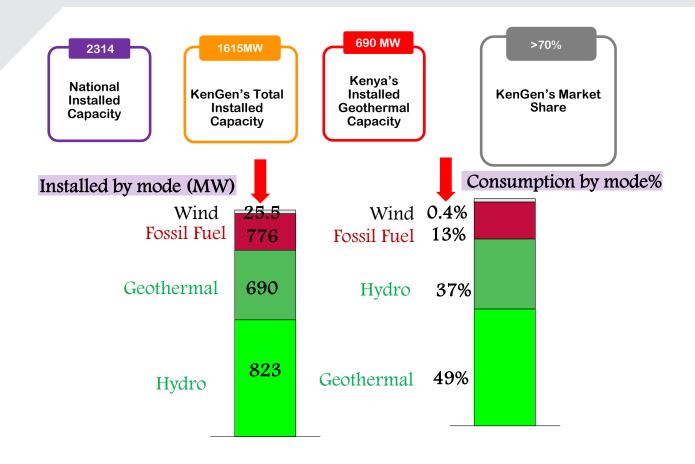
Source: TGE Research (2017), GEA (2016), IGA (2015), JESDER (2017) Enerji Atlasi (2017)

GEOTHERMAL POTENTIAL IN KENYA



- □ Kenya's geothermal potential in excess of 10 GWe
- ☐ Endowed within the Kenyan Rift
- ☐ Over 23 geothermal fields/prospects
- ☐ Installed capacity: 690 MWe
- Direct utilization

INSTALLED CAPACITY



Geothermal Development Journey (1956-1985)

1956-1959

- Two Exploratory wells drilled to a depth of ~950m
- Wells never discharged and later abandoned

1967-1970

- GoK & UNDP entered into an agreement to extensively undertake geothermal resource assessment

1971-1976

- Decision was made to concentrate geothermal development at Olkaria (80km²) after positive well results.
- Six wells were drilled with positive results
- -Feasibility study by Fweko Virkir in 1976, recommending drilling of wells for Olkaria I Plant

1977-1985

- Drilling was accelerated and 29 wells were drilled
- 45 MW (Olkaria I) commissioned between 1981-1985
- Most financing was from World Bank

Geothermal Development Journey (1986-2017)

1986-2003

- Drilling continued in Olkaria
 Il Steam field ~ 30 wells by
 1992
- From 1992, financiers pulled out and no major works undertaken until 1999
- -Orpower 4 Inc. (IPP) issued with Geothermal Resource Licence for development of Olkaria III in 1998.
- Six wells drilled in Eburru
- Surface exploration at Suswa & Mt longonot
- 3 exploratory wells drilled at Olkaria Domes with success in 1999
- Direct use of geothermal energy for flower growing in 2001
- -70MWOlkaria II commissioned in 2003

2004-2010

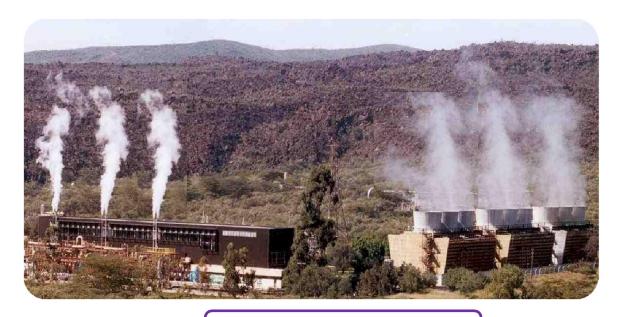
- Surface exploration in Menengai, Arus-Bogoria, Koros-Chepchuk & Paka.
- -Formation of GDC as a government SPV in 2009
- -1st Optimization study for Olkaria geothermal resource by WestJec in 2009
- 35MW Olkaria II Unit 3 commissioned in 2010
- -Drilling at Olkaria by GWDC, funded by Chinese government
- -Identification of the 280MW development at Olkaria
- Geothermal Resources Licence issued to WalAM Geopower Inc. (IPP) for exploration and development of Suswa geothermal field.
- -Geothermal licence issued to AGIL. (IPP) for exploration and development of Mt Longonot geothermal field.
- -Geothermal Resource Licence issued to Marine Power Generation (IPP) for exploration and development of Akiira geothermal field.

2011-2017

- 2nd optimization study for Olkaria geothermal resource
- -KenGen acquired 2 drilling rigs while GDC acquired 7.
- -Drilliing in Menengai by GDC
- Continued drilling at Olkaria; EXIM bank financed drilling of 89 wells at Olkaria for Olkaria IU6, Olkaria V, VI & VII Power Plants
- -Installation & commissioning of well head generating units at Olkaria & Eburru
- -Commissioning of 280MW project Olkaria IV & Olkaria I AU 4 &5 in 2014
- -Development & operationalization of Olkaria geothermal spa
- Geothermal licence issued to OlSuswa Energy (IPP) for exploration and development of Barrier geothermal field.

Geothermal Development Milestones: Olkaria

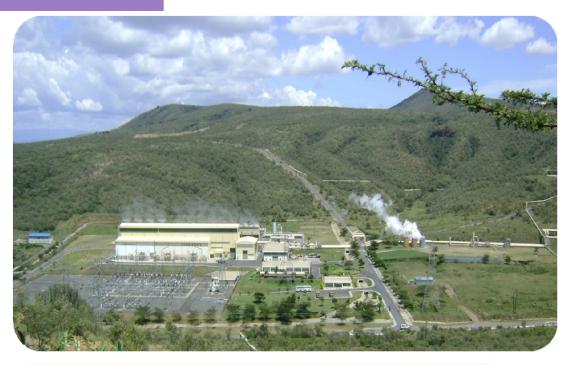
OLKARIA I POWER PLANT (45 MW)



COMMISSIONED IN 1981-1985

INSTALLED CAPACITY: 45 MW

OLKARIA II POWER PLANT



UNIT 1 & 2 COMMISSIONED IN 2003

UNIT 3 COMMISSIONED IN 2010

INSTALLED CAPACITY: 105MW



OLKARIA IV POWER PLANT



COMMISSIONED IN 2014

INSTALLED CAPACITY: 150MW



WELLHEAD TECHOLOGY POWER PLANTS

GEOTHERMAL WELLS

Olkaria

OW-37, OW-39,

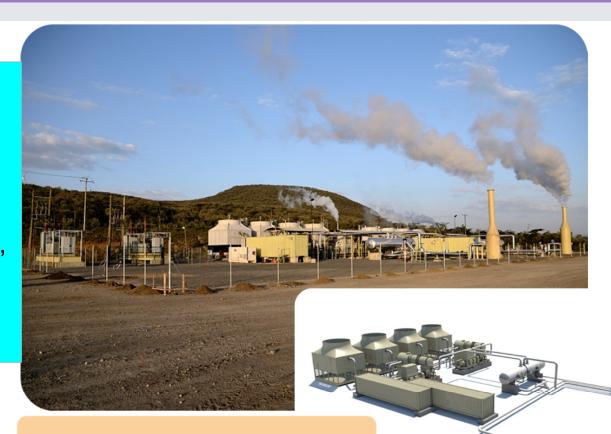
OW-39, OW-43,

OW-914, OW-915,

OW-919, OW-905

Eburru

EW-01



NO. OF UNITS: 16

INSTALLED CAPACITY: 83.5MW



OLKARIA I AU (UNIT IV&V) POWER PLANT



COMMISSIONED IN 2015

INSTALLED CAPACITY: 150MW



Geothermal Development: Eburru



- 6 exploration wells drilled (1989 to 1991)
- EW-01 under production.
- 2.4 MWe Well head Plant (Jan, 2012)
- Plans to put up a 25 MWe plant
- Geoscientific studies commenced-2016-2017

Geothermal Development: Orpower



- Granted generation license in 1998 for the Olkaria West Field
- About 9 wells had been drilled by KPC (KenGen's) predecessor ~ 1983
- 1999 KenGen retested some of the wells in Olkaria West
- Ormat Pilot Plant commissioned in July 2000 (12 MWe)
- 9 more wells drilled for both appraisal and production (36 MWe expansion)
- Drilling continued from 2011 to date
- Capacity 160 MWe

Geothermal Development: GDC



- Purpose Vehicle (SPV) to accelerate development of geothermal resources
- Geothermal Power plants:
 - ➤ It is under development
 - > 3 IPP contracted
 - (i) Sosian Energy,
 - (ii) Ormat technology and,
 - (iii) Mauritius based Quantum
 Power
 - Capacity 35 MW each

KEY PLAYERS IN GEOTHERMAL SECTOR

No.	PLAYER	FIELD/PROSPECT
1	KENGEN	Olkaria& Eburru
2	GDC	Menengai, Suswa, Bogoria-Arus- Silali
3	Orpower	Olkaria III
4	GDC	Suswa
5	Marine Power Generation	Akiira field
6	KAISHAN Group	Suswa South-Magadi Shombole area
0	Africa Geothermal International Ltd (AGIL)	Longonot
8	Olsuswa Energy Ltd	Barrier

GENERAL STATUS OF GEOTHERMAL FIELDS, PROSPECTS AND THEIR POTENTIAL

FIELD/PROSPECT	STATUS UPDATES (Stages of Development)	
OLKARIA	Production& Monitoring stage	
MENENGAI	Production drilling ongoing, Steam gathering system	
	&Transmission line construction. Contract for 35MW	
	awarded to Sosian Energy Group	
EBURRU	Generation stage Detailed exploratory work in 2016-2017	
	Plans underway for expansion	
SUSWA	Detailed surface studies completed by 2013. Awaiting	
	exploration drilling	
LONGONOT	Surface exploration studies done and exploratory wells sited	
	Awaiting exploration drilling	
AKIIRA	Exploration drilling of 2 wells done.	
ARUS-BARINGO-	Surface exploration done. Installation of waterline near	
SILALI	completion for exploration drilling to commence.	
BARRIER	Detailed geoscientific studies on schedule after signing of	
	MOU with the Turkana county government	
OTHER PROSPECTS	Preliminary surface exploration done	

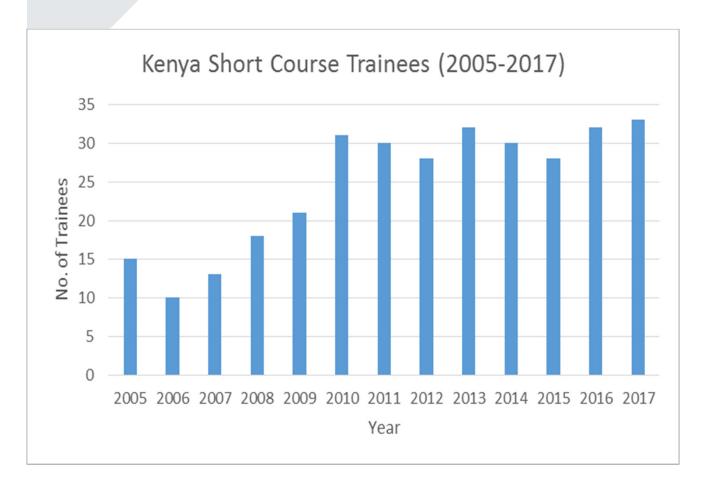
STATUS OF GEOTHERMAL FIELDS, PROSPECTS AND THEIR POTENTIAL CONT.

No.	FIELD/PROSPECT	ESTIMATEDPOTENTIAL	TARGET OUTPUT
1			OLK 1 UPGRADE 7MWe by 2019
			OLK Tapping units 60 MWe by 2019
	OLKARIA	823 MWe	OLKV 158 MWe by 2019
			OLK 1AU6 70 MWe by 2019
			OLK Modular plants 108 MWe by 2019
			OLK VII, VIII & IX 140 MWe each -2019
2	MENENGAI	1600 MWe	100 MWe by 2018
3	EBURRU	70 MWe	25 MWe by 2020
4	SUSWA	750 MWe	150 MWe by 2018
5	LONGONOT	200 MWe	70 MWe by 2018
6	AKIIRA	200 MWe	70 MWe by 2018
7	ARUS-BARINGO-SILALI	3000 MWe	100 MWe by 2018
8	OTHER FIELDS(KENGEN)	UNDER PROSPECTING	1000 MWe by 2025

DRIVES OF ACCELERATED GEOTHERMAL DEVELOPMENT IN KENYA

- ➤ The continuous collaborative capacity building between the Icelandic UNU-GTP and Kenyan institutions
 - Short course, 6-months, MSc a and PhD programs
- Government strategies, regulatory and policy framework
 - The 40-months challenge for addition of 5,000 MWe with geothermal contributing 1,646 MWe
 - Global focus on renewables energy

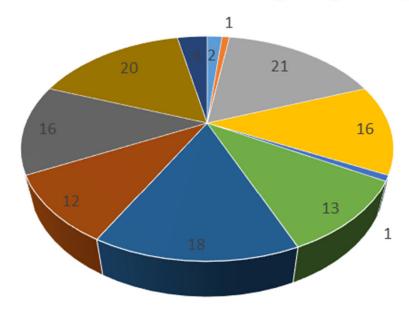
UNU-GTP-KENGEN-GDC CAPACITY BUILDING: SHORT COURSE TRAINING



- ✓ Training initiated in 2005
- √ 321 number of trainees to date
- √ 3 week course program
- ✓ Average of 30 trainees per year

UNU-GTP CAPACITY BUILDING: 6 MONTHS PROGRAM

Specialized 6-Months Training Programs (1979-2017)



- Geothermal geology_(2)
- Borehole geology_(21)
- Borehole geophysics_(1)
- Chemistry of thermal Fluids (18)
- Geothermal utilization_(16)
- Project Management & Finance_(4)

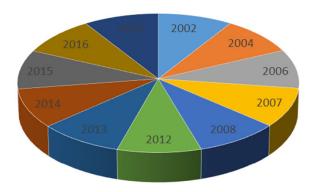
- Geological exploration_(1)
- Geophysical exploration (16)
- Reservoir engineering_(13)
- Environmental Science_(12)
- Drilling technology_(20)

- ✓ Training initiated in 1979
- ✓ Total of 124 graduates
- √ 11 areas of specialized training
- ✓ Borehole geology with highest no. of graduates (21)



UNU-GTP CAPACITY BUILDING: MSC PROGRAMS

No. of Kenya MSc students Per year/ Areas of specialization



- Reservoir Engineering & Chemistry of Thermal Fluids (2)_2002
- Chemistry of Thermal Fluids (1)_2006
- Geothermal Utilization (1)_2008
- Geophysics (1)_2013
- Mechanical Engineering (2)_2015
- Geothermal Utilization, Drilling technology & Reservoir Engineering (3) _2017

- Environmental Science & Geology (2)_2004
- Environmental Science(1)_2007
- Chemistry(1) 2012
- Mechanical Engineering (2) &Geology (2)_2014
- Geology (2) & Reservoir Engineering (1)_2016

- ✓ Training initiated in 2002
- ✓ Total of 21 graduates
- √ 8 areas of specialized training
- ✓ Geology with highest no. of graduates (5)

Additional contributions of UNU-GTP and Iceland Organizations and Government

- Customized trainings in Kenya
- ✓ Workshops for Decision-Makers for various countries of E-Africa
- ✓ Advisory services in support of establishment of Africa Geothermal Centre of Excellence (AGCE) in Kenya with assistance of UNEP - Africa Rift Geothermal (ARGEO)
- ✓ Financings- through ICEIDA of Iceland and the Nordic Development, Iceland Ministry of Foreign Affairs

CONCLUSION

- □ Acceleration of geothermal development in Kenya has largely been achieved through investing in human capital.
- ☐ The contribution of UNU-GTP of Iceland towards these achievement cannot be overemphasized.
- ☐ Enabling environment through support Government of Kenya in terms of policy formulation and enactment that triggers geothermal development and,
- ☐ Financial support from development partners

ACKOWLEDGEMENTS

- ☐ Director of UNU-GTP-Ludvik Georgsson and

 Ms. Málfrídur Ómarsdóttir at UNU-GTP for providing
 the training data
- ☐ KenGen support UNU-GTP 40 year anniversary in recognition of its crucial role in capacity building for geothermal development in Kenya