SELECTED COUNTRIES - KENYA & BANGLADESH

SWITCH ENERGY CASE COMPETITION 2023

TEAM OUTCASTS - INDIA

"We want our legacy to stand upon youths. We want to give knowledge to the young generation and be a part of changing the game."

Takeoff - Algerian Musician

TEAM MENTOR Kash Kashikar

TEAM MEMBERS Priyanshu Kumar, Om Bhanudas Palwe, Pratyush Singh, Shubham Choudhary

OUTCASTS

TEAM NUMBER : 183

HOME COUNTRY : INDIA

INTRODUCTION
KENYA & BANGLADESH

OUTCASTS

The goal for Kenya is to **eliminate energy poverty**, **enhance public health** through the adoption of cleaner cooking fuel alternatives and **increasing electricity generation capacity** of renewable energy sources , and establish a comprehensive, **long-term plan for sustainable energy development.**

How can Kenya effectively navigate the array of challenges it faces in its energy development, including ongoing political instability, the **potential impact of a global economic recession**, and **widespread energy poverty**, to emerge with a **stronger and more resilient economy?**

The approach focuses on **sustainable development** and **effective planning** for revamping Kenya's energy infrastructure in a way that **maximizes the use of renewable energy** sources, **minimizes carbon emissions**, and takes **threats** and **alternatives** into consideration.

With detailed analysis, **financial budgeting**, and discussion of **immense energy potential Kenya** holds, this study would **motivate the Govt in Kenya**, investors to put much efforts in exploiting renewable energy resources.

GENERAL INFORMATION

KENYA

Ref: International Energy Agency: IEA

Population: **55 million** (2022)

HDI ranking : **152** out of 191

Rural Population : **39.05 million**

GDP : **$113.42 billion** (2022)

Total Area : **582,646 km^2**

No. of States : **47 Counties**

GDP per capita : **$2,099** (2021)

Literacy Rate : **82.62%**

Unemployment Rate : **5.5 %**

Main Economic Sector

Agriculture, **Tourism**, **Telecommunication**

GENERAL INFORMATION
BANGLADESH

OUTCASTS

Ref: International Energy Agency: IEA

Population : **173 million** (2022)

Rural Population : **103 million**

Total Area : **147,570 km^2**

GDP per capita : **$2,687** (2022)

Unemployment Rate : **4.7%**

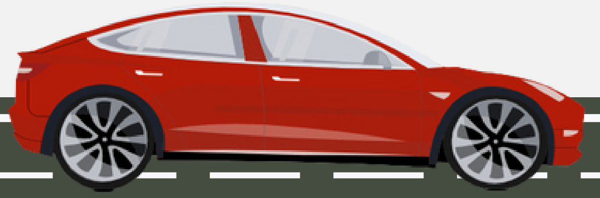
HDI ranking : **129** out of 191

GDP : **$460.20 billion** (2022)

No. of States : **8 States**

Literacy Rate : **74.66%**

Main Economic Sector
Service, Agriculture, Textile



ENERGY OVERVIEW

ENERGY TIMELINE
KENYA

OUTCASTS

Ref: International Energy Agency: IEA

2006-07

Energy Act 12 of 2006

Energy Regulatory Commission established

2008-09

Feed-in tariffs for Renewable Energy Resource Generated Electricity

Energy Regulation 1009 on Biodiesel Licensing

2010-11

Revised Feed-in-Tariffs for Renewable Energy

Least Cost Power Development Plan 2011-2031

2012-13

Kenya's progress on electricity access

2nd revision of Feed-in tariffs for Renewable Energy

Solar water heating regulations

2014-18

New standards for energy devices in Kenya

Tax incentives for renewable energy

National Energy Policy

2019-2022

Non-ducted air conditioners Testing and rating performance

Kenya Off-Grid Solar Access Project

2022 Reduction of electricity tariffs

Cooking gas consumer support

2022-23

2022 & 2023 fuel subsidy scheme-Petroleum Development Levy Fund.

ENERGY TIMELINE

BANGLADESH

OUTCASTS

Ref: International Energy Agency: IEA

1996

Private Sector Power Generation Policy of Bangladesh 1996

Policy Guidelines for Small Power Plants in Private Sector

2003

The Act of 2003 established the Bangladesh Energy Regulatory Commission to regulate the energy sector

2004

Import Duty Exemptions for Solar and Wind of Bangladesh (Statutory Regulatory Order)

2009

The Renewable Energy Policy of Bangladesh aimed to promote sustainable and clean energy sources.

2012

The Sustainable and Renewable Energy Development Authority Act 2012

2015

Scaling Up Renewable Energy Program for Bangladesh

Energy Efficiency and Conservation Master Plan up to 2030

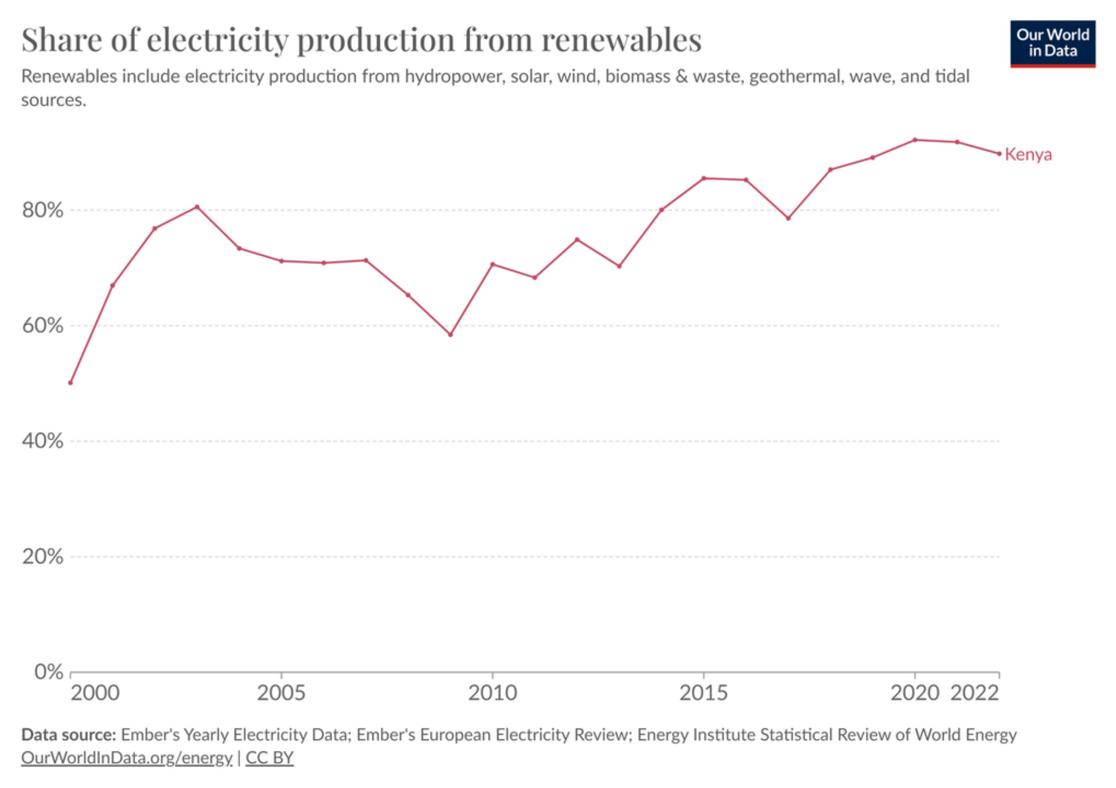
2021

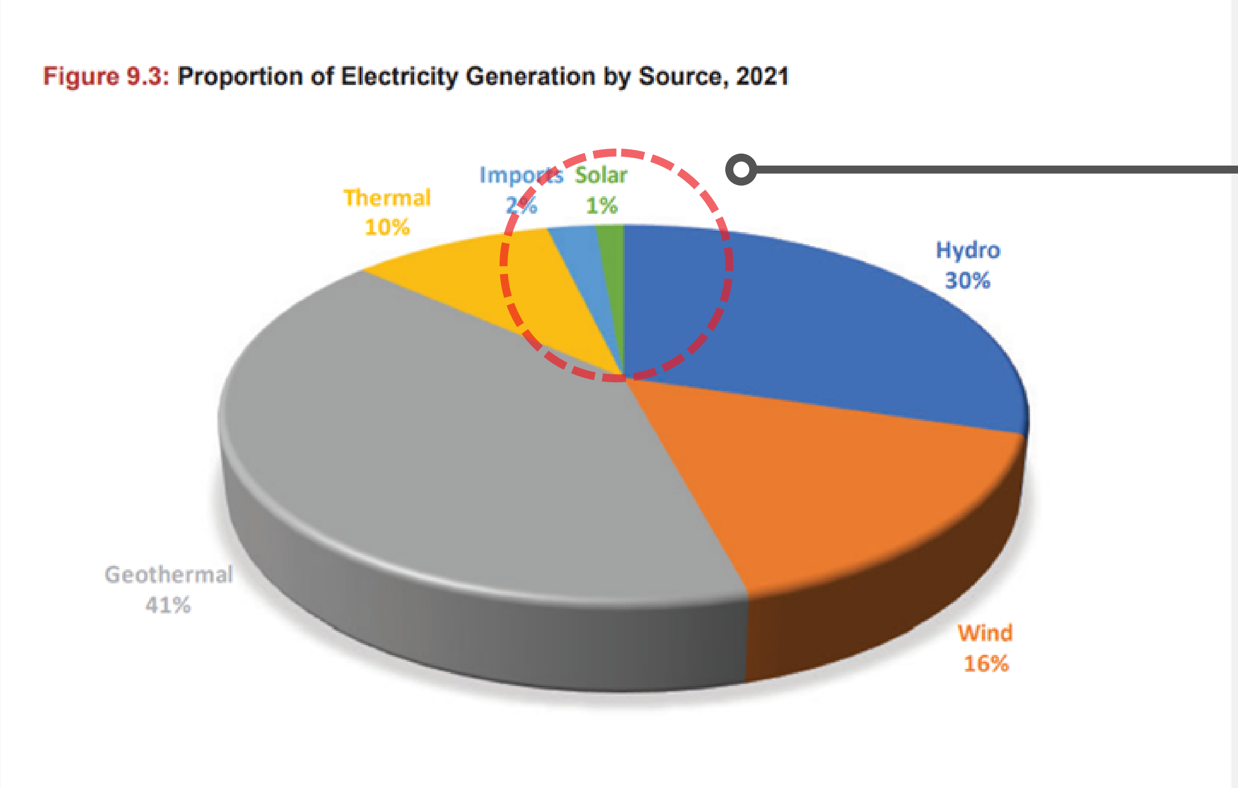
2021 to 2023 increase in fuel, electricity and gas subsidies

Ref: www.ourworldindata.org

ENERGY MIX

- Power generation in Kenya **increased by 4.5%** in the financial year ended 30 June 2022 to **12.7 TWh**, with **39% of geothermal**, **26% of hydro**, **16% of wind**, **13% of thermal**, 3% of imports and 2% of solar, according to the Kenyan Energy & Petroleum Regulatory Authority (EPRA).





- **Solar** has been at a **lower contribution to Kenya**'s Electric Generation, which is concerning.
- Geothermal is playing an important role in contribution, but Kenya doesn't utilize it at its maximum potential.

- Since Kenya is actively generating electricity from renewable sources, we should expand the spectrum of technologies for Kenya's renewable sources.

OVERVIEW

KENYA
ENERGY OVERVIEW

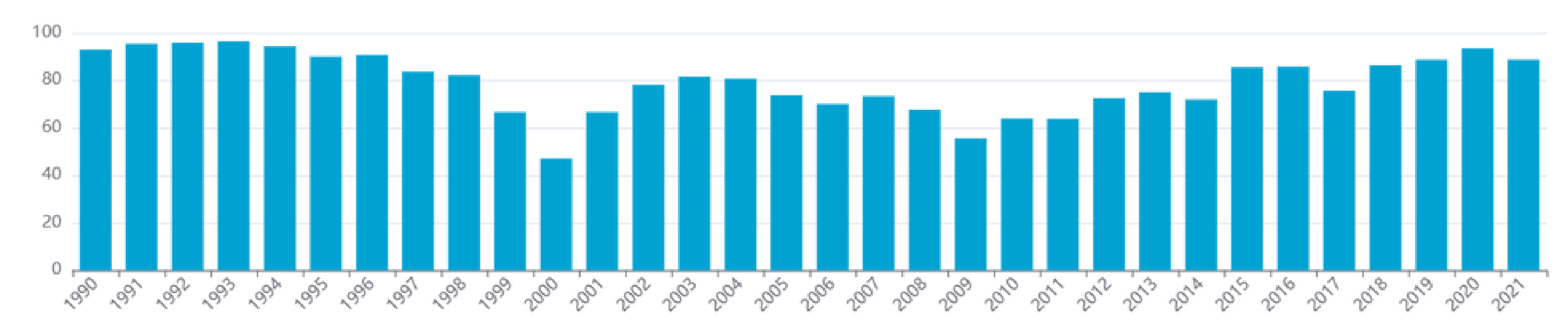
OUTCASTS

Ref: www.sciencedirect.com

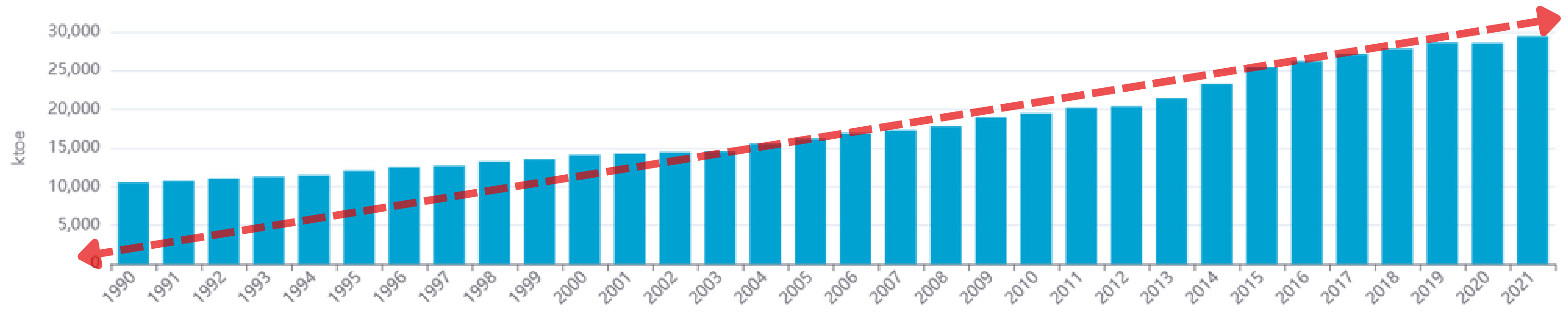
ENERGY CONSUMPTION PER CAPITA

- Energy consumption per capita in Kenya is **0.54 toe**, including around **180 kWh** of electricity (2021).
- The country's overall energy consumption has increased steadily in recent years, at an average rate of **3.8% per year** from 2010 to 2021.
- Renewable energy accounts for a growing share of Kenya's energy mix, with **geothermal** and **hydroelectricity** being the two main sources.
- In 2021, renewable energy accounted for **79% of Kenya's total energy consumption**.

Kenya's per capita energy consumption is **relatively low** compared to developed nations, with the majority of the population relying on biomass/firewood for cooking and heating. While efforts have been made to improve access to electricity and diversify energy sources, challenges remain in meeting the growing energy demands of a rapidly expanding population.



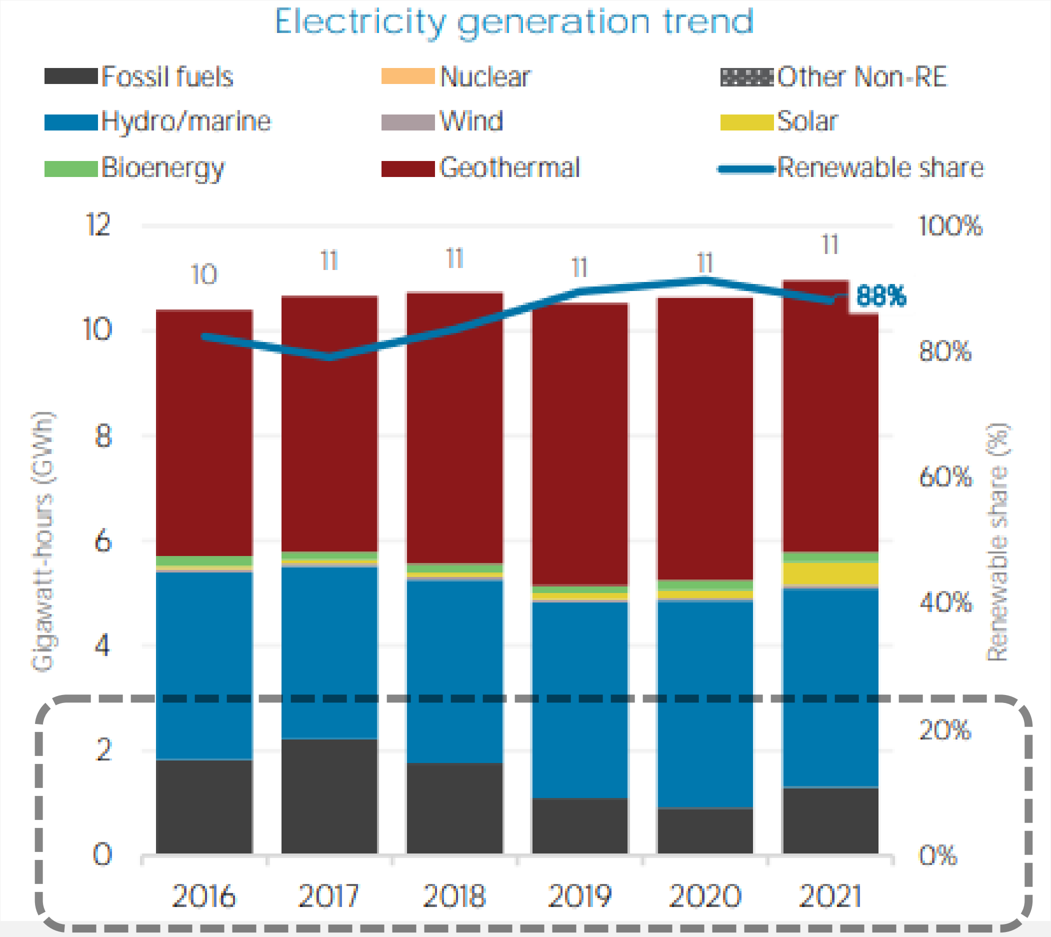
Share of Renewable Energy Resources in Electricty Production % (incl Hydro)

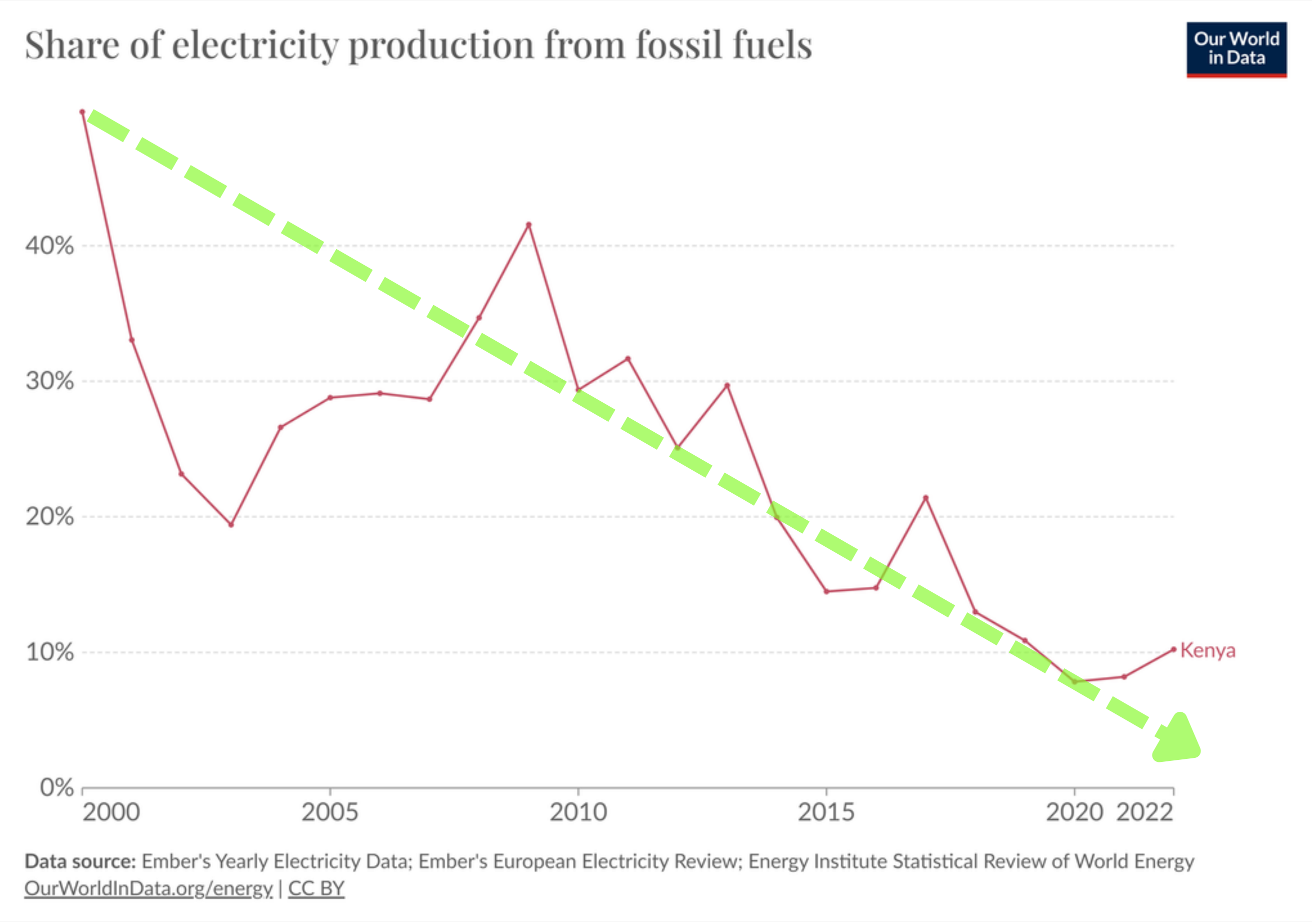


Kenya Total Energy Consumtion (in ktoe)

HISTORY OF KENYA - BASED ON SOURCES

OUTCASTS





Crude Oil Prices - 2020 - 2023

- Unlike most other countries, **the production of electricity from fossil fuels is minor** as compared to geothermal and hydroelectric. (especially in the last two decades).
- Kenya has **all of its crude oil imported from other countries**. Thus, comparing the two graphs, we can clearly see that whenever the price of **crude oil has increased, the generation of electricity from fossil fuels has decreased**.

BANGLADESH
ENERGY OVERVIEW

OVERVIEW

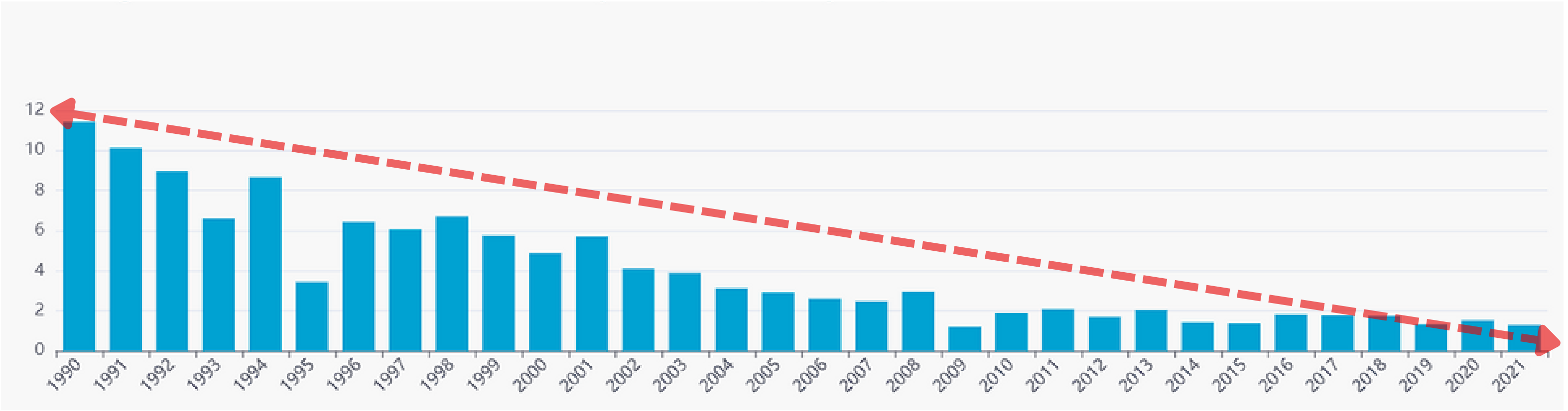
OUTCASTS

Ref: www.sciencedirect.com

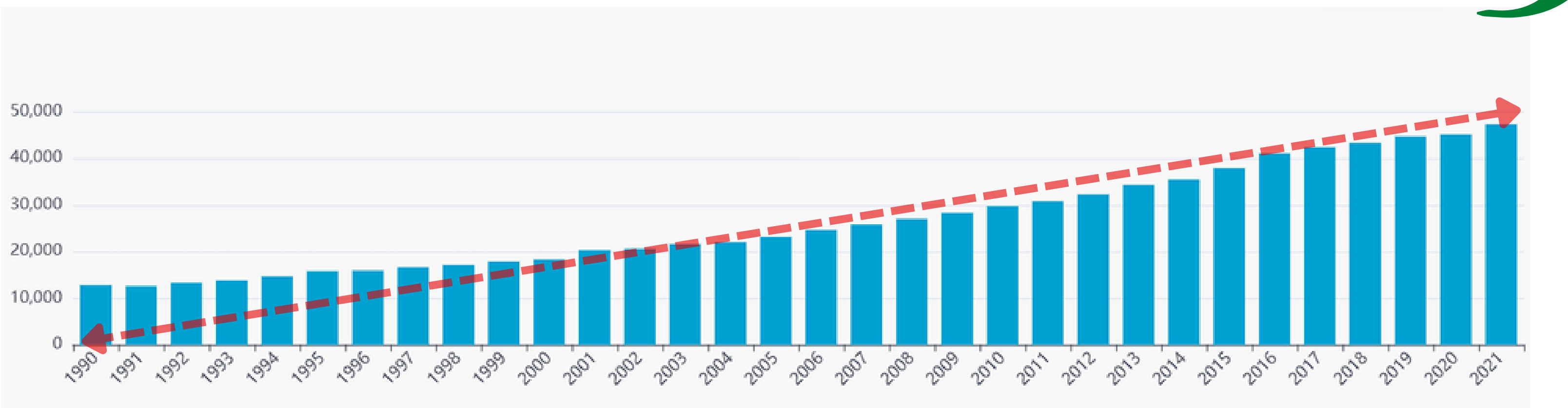
ENERGY CONSUMPTION PER CAPITA

- Energy consumption per capita is **0.28 toe**, including around **497 kWh of electricity** (2021).
- The country's overall energy consumption **increased quickly during 2010-2016** (5.5%/year on average, driven by rapid economic growth (6.3%/year on average in the same period).
- The annual increase has been smaller since then, at around **2.9% per year** between 2016 and 2021.
- **Gas is the main energy source (59%)**, ahead of oil (18%), biomass (17%), and coal (4%) (2021).

Bangladesh had one of the **world's lowest per capita energy consumption rates** due to a large population and reliance on traditional biomass fuels. The country has been working to expand access to electricity, promote renewable energy, and address infrastructure challenges to meet growing energy demand.



Share of Renewable Energy Resources in Electricty Production % (incl Hydro)



Bangladesh Total Energy Consumtion (in ktoe)

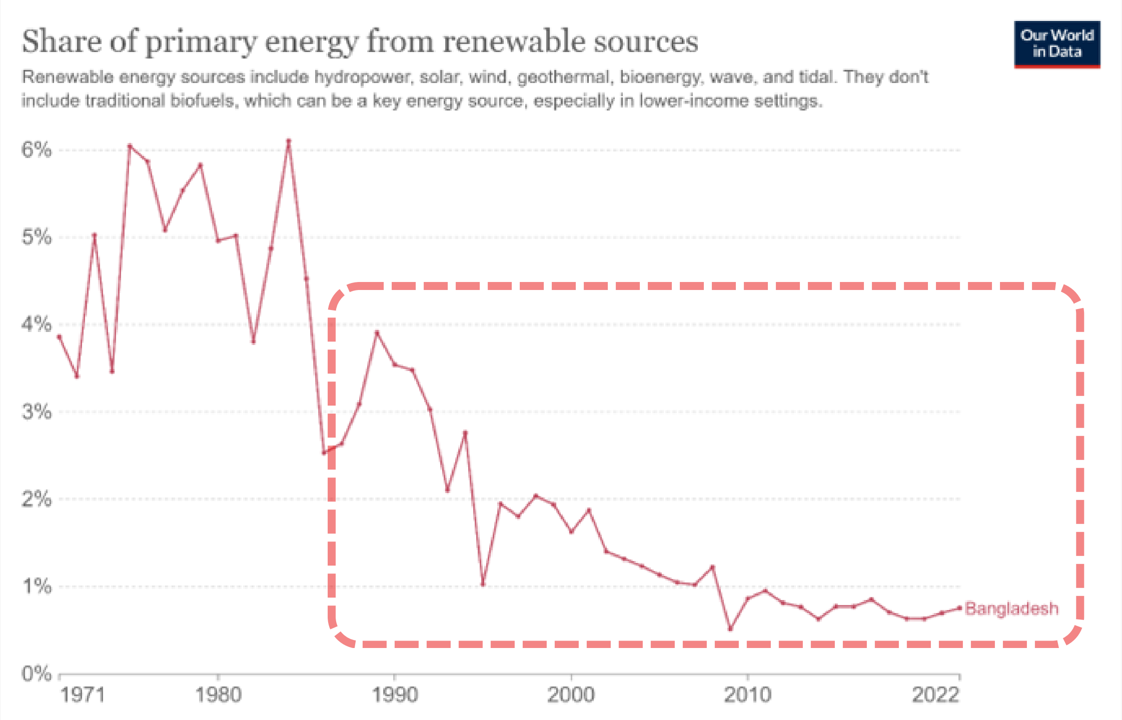
BANGLADESH ENERGY MIX

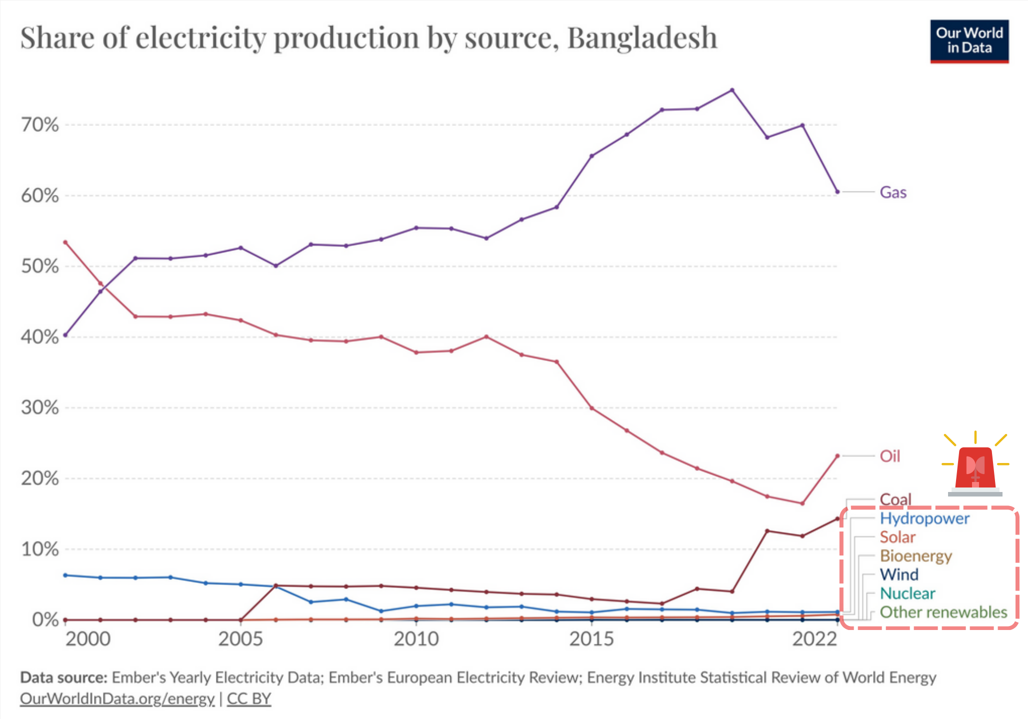
OUTCASTS

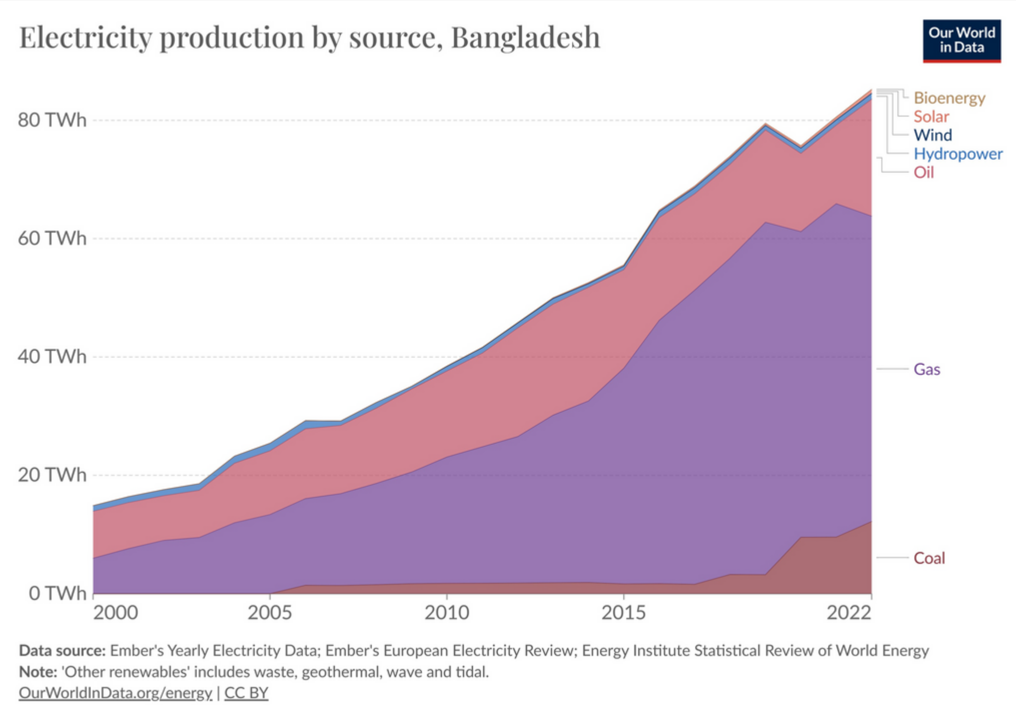
Ref: ourworldindata.org

SHARE OF PRIMARY ENERGY FROM RENEWABLES

- In 2022, renewable energy sources accounted for less than 2% of Bangladesh's electricity production.







- Bangladesh has been developing electricity from **natural gas and fossil fuels since earlier times**. Due to this, it has better energy infrastructure for electricity generation from non-renewable resources.
- As the **energy requirement of Bangladesh is rapidly increasing**, they are relying more and more on their reliable alternative of natural gas and cheap alternative coal.
- Due to this, the natural gas reserve in Bangladesh may be **exhausted in few decades**, causing its fossil fuel imports to increase rapidly.

OVERVIEW

OUTCASTS

KENYA

ENERGY SPECTRUM

REFUGEE

WATER SANITATION

POLITICAL PROBLEMS

MALNUTRITION

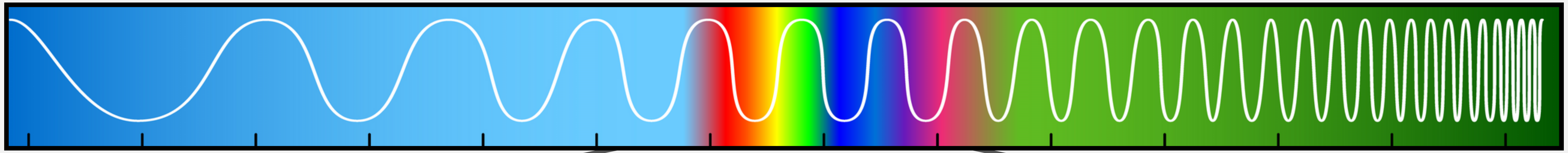
ENERGY POVERTY

AGRICULTURE ISSUES

ECONOMIC ISSUES

ACCESS TO EDUCATION

HEALTH CARE ISSUES



MAJOR PROBLEMS

- LARGE CO2 EMISSIONS
- CLEAN COOKING FUEL
- HIGH ELECTRICITY COSTS
- POOR TRANSMISSION
- HIGH IMPORTS OF OIL & GAS
- LIMITED USE-CASE OF GEOTHERMAL
- WATER POLLUTION
- INSIGNIFICANT USE OF SOLAR

- SAFETY
- POTENTIAL FOR ROADBLOCKS
- RELIABILITY
- SECURITY
- ACCESSIBILITY
- AFFORDABILITY
- QUALITY OF ENERGY SERVICE
- ENVIRONMENTAL IMPACT

FACTORS FOR ENERGY POVERTY

OVERVIEW

KENYA
ENERGY POVERTY

OUTCASTS

01 Accessibility

Urban Electricity Access : **97%**
Rural Electricity Access : **62%**
Clean Cooking Fuel : **20%**

02 Reliability

Currently Kenya generates about **2993 MW** of energy, which is not sufficient for its **55 million population**. This has caused multiple long power outages spanning several hours.

03 Environmental Impact

CO2 emission : **0.44** Metric ton (2019)
Renewable Energy Usage : Over **80%**

04 Affordability

Price of electricity :
0.176 US Dollar per kWh

World Energy Trilemma Score

51.1

Multidimensional Energy Poverty Index

05 Safety

In 2019 alone in Kenya, **19000** deaths have caused due to air pollution.
PM 2.5 > 10 µg/m3
(normally it must be less than 5)
(mainly due to release of black carbon)

06 Quality of Energy Services

Transmission losses are **4.5%**.
Distribution losses are **15%**.
Non-technical losses are **15%**.

07 Security

As of 2019, Kenya imported around **212 Million** kilowatt hours of electricity.

08 Potential for Roadblocks

Consumers pay significantly **higher rates** for electricity.
Lack of Infrastructure.

OVERVIEW

BANGLADESH

ENERGY POVERTY

OUTCASTS

01 Accessibility

Urban Electricity Access : **100%**
Rural Electricity Access : **98.5%**
Clean Cooking Fuel : **25%**

02 Reliability

Only **48 hours** of interruption in the grid as compared to **136 hours** in 2011 (BPDB 2020; 2011).

03 Environmentally Impact

CO2 emission : **0.55 metric ton** (2019)
Renewable Energy Usage : **3.5%**

04 Affordability

Price of electricity :0.075 U.S. Dollar per kWh
Percentage of income spend on energy :4.34 %

05 Safety

36% of deaths attributed to fossil fuel driven air pollution

06 Quality of Energy Services

Distribution & Transmission losses : **14%**
Collection efficiency > **90%**

07 Security

Natural gas reserves : **10.42 trillion** cubic feet
Imported power : **5%**of total electricity

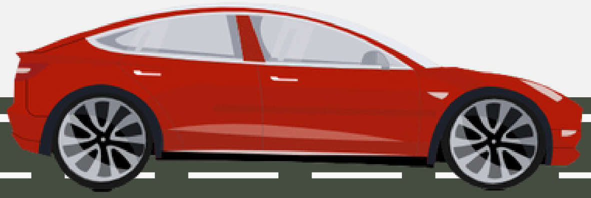
08 Potential for Roadblocks

Supply **chain disruption**
Large dependency on energy imports

World Energy Trilemma Score

47.8

Multidimensional Energy Poverty Index



ENERGY OVERVIEW

COMPARITIVE ANALYSIS

PHASE PLAN 01 - 02 - 03

IMPACT ON KENYA

FEASIBLITY IN BANGLADESH

IF OUR PLAN GOES SOUTH

CONCLUSION

COMPARITIVE ANALYSIS

CO2 EMISSIONS

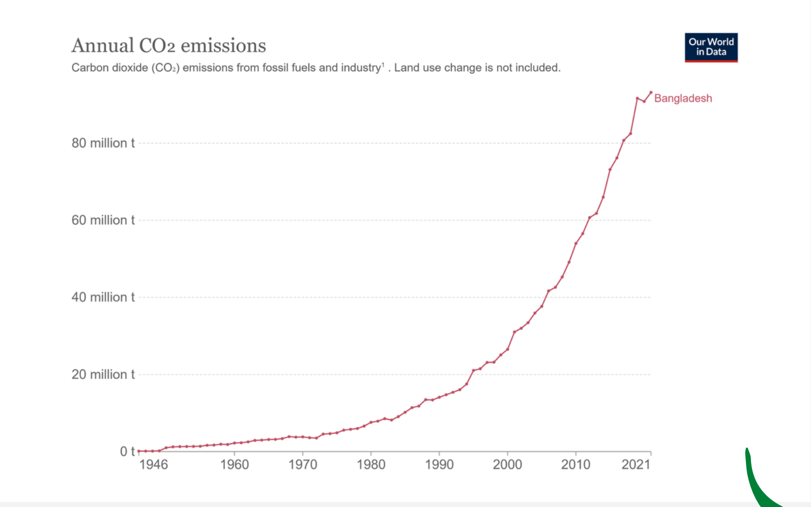
COMPARITIVE ANALYSIS

OUTCASTS

Ref: ourworldindata.org

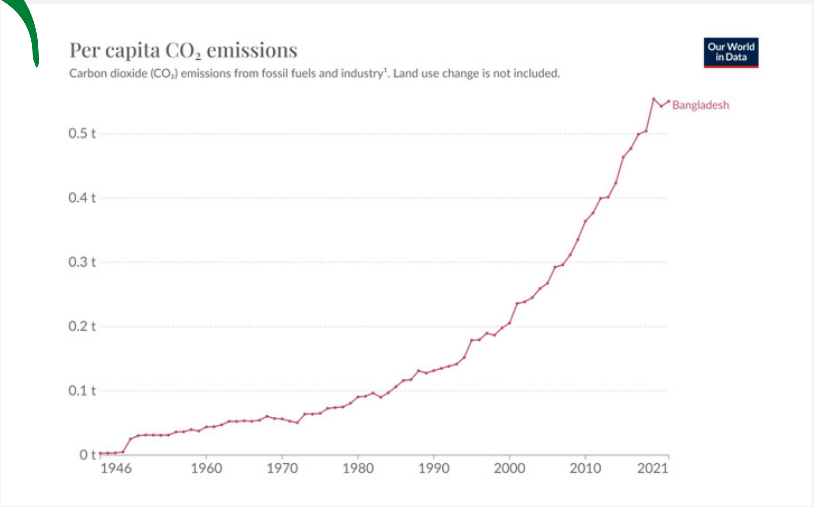
BANGLADESH

- The **increased share of oil** in the electricity generation mix has led to higher CO2 emissions in Bangladesh.
- Around **94.3 million tonnes of CO2** were emitted in 2019, of which 23.1 million tonnes (i.e., nearly **24.5%**) are from **oil combustion**. **Natural gas** accounts for nearly **66.4% of total CO2 emissions** in Bangladesh and **coal for 9.1%**.



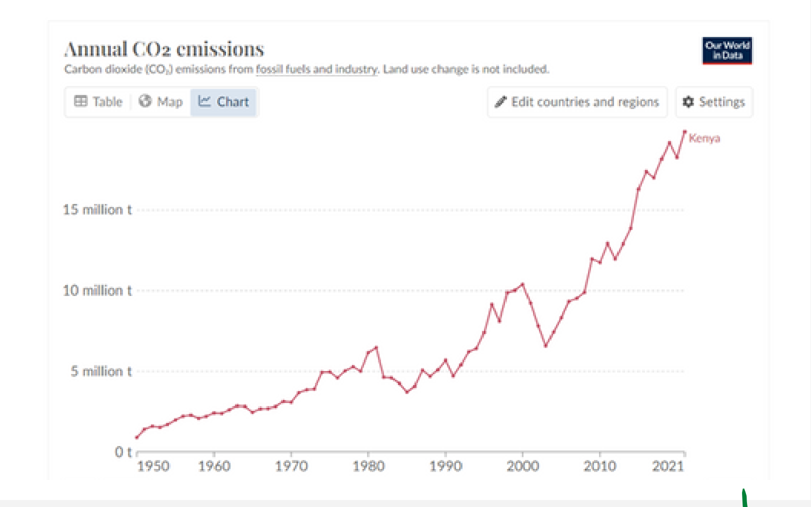
Rapid **increase in population** caused the LPG and CNG usage to increase quickly.

Burning of fuels was aided by the availability of natural gas and fossil fuel reserves in Bangladesh.



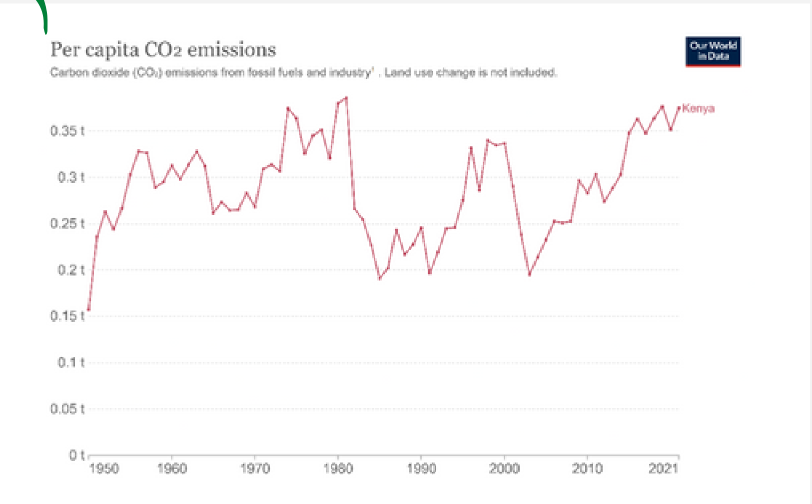
KENYA

- . Kenya's carbon dioxide (CO2) emissions from the power industry account for **17.5%** of the country's total emissions..
- In 2019, Kenya's residential cooking carbon emissions were estimated to amount to the equivalent of 24.8 megatonnes of carbon dioxide annually.



CO2 emissions can be attributed to population growth, expanding industrialization, and energy demand. These factors have led to **greater fossil fuel use**, deforestation, and land-use changes.

Firewood is being used as **primary cooking fuel** in every state of Kenya. (Even today)



WATER POLLUTION

COMPARITIVE ANALYSIS

OUTCASTS

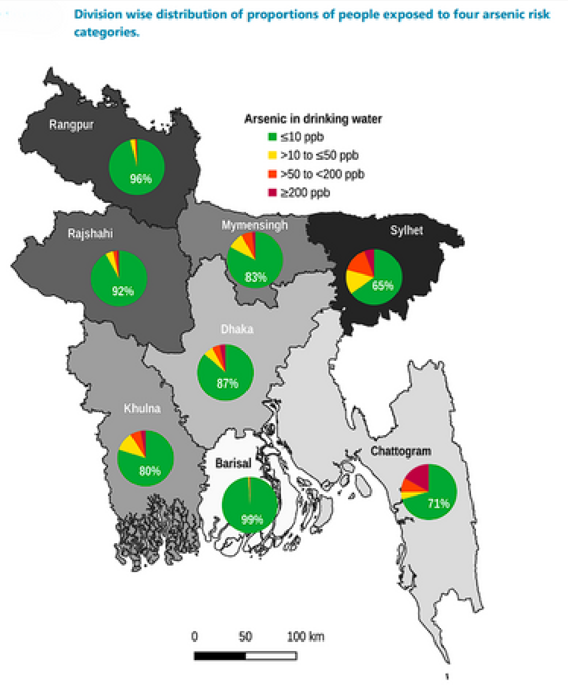
Ref: www.sciencedirect.com

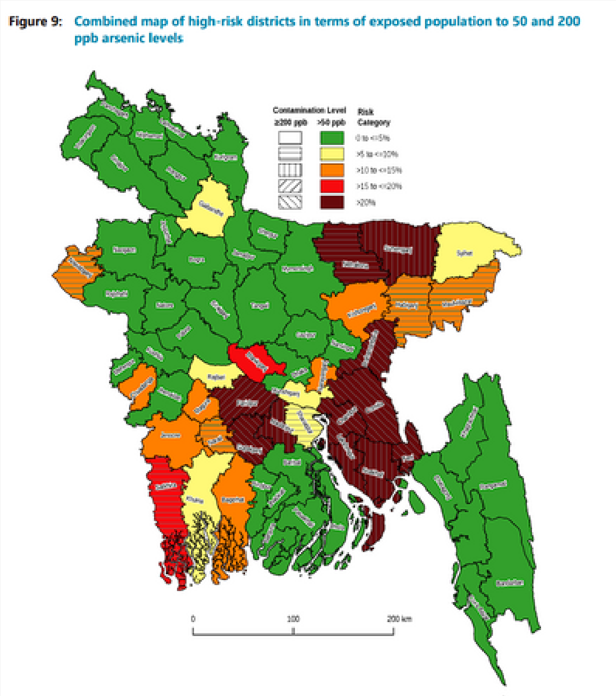
BANGLADESH

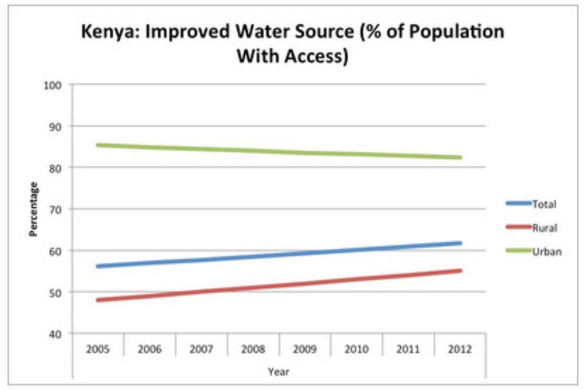
- **<u>350,000 kilogrammes</u> (350 metric tons) of toxic waste** is dumped into rivers every day from about 7,000 industries and other residential areas.
- **1.12 million of the four million wells** in Bangladesh are contaminated with **<u>arsenic</u>**.
- **35% of households** have **<u>access</u>** to drinking water that is free from both **arsenic** and **microbial contamination**.

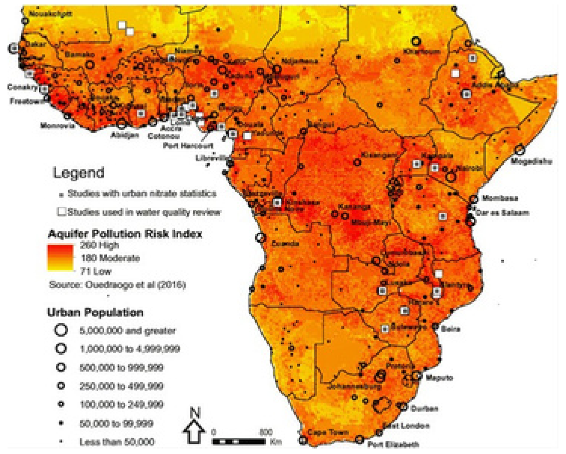
KENYA

- With a population of 53 million, about **28 million (~51 %)** Kenyans lack **<u>access to safe water</u>** and **41 million (~77 %)** lack access to **<u>improved sanitation</u>**.
- Growing water demand and water scarcity have turned into a **notable challenge in Kenya**.









ACCESS TO CLEAN COOKING FUEL

COMPARITIVE ANALYSIS

OUTCASTS

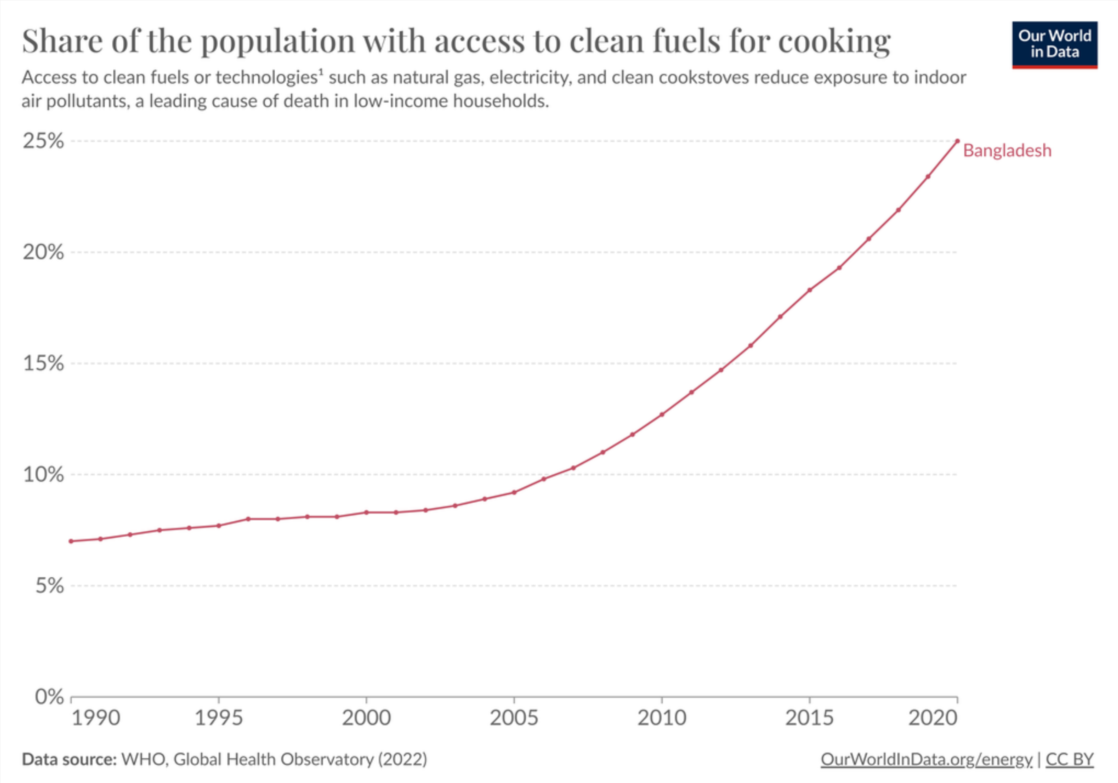
Ref: ourworldindata.org

BANGLADESH

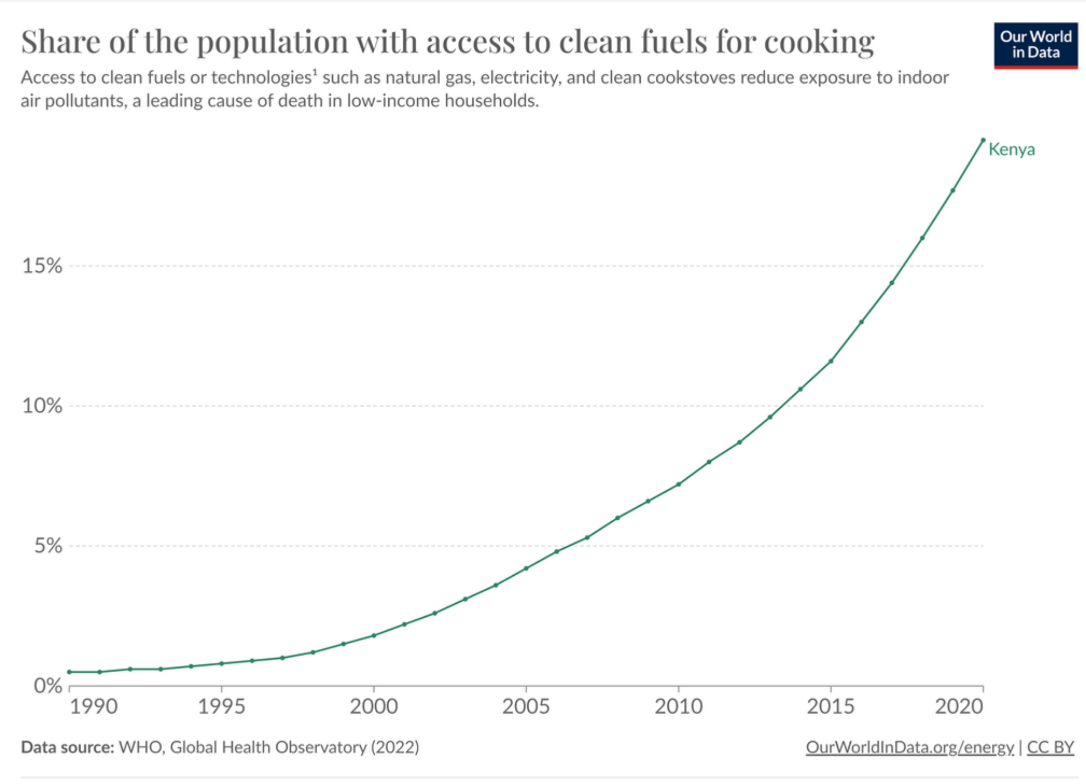
- A staggering **129.33 million people**, or **77% of the population**, did not have access to clean fuels and technologies for cooking at home.
- Bangladesh's efforts to achieve a 35% access rate to clean energy for cooking faced a **setback as the rate fell to 28%** in 2022, marking a **1.9% decrease** from the previous year

KENYA

- Access to clean fuels and technologies for cooking (% of population) in Kenya was reported at **23.9 % (Total Population 51 million)** in 2021.
- Majority of people in Kenya rely on **firewood and charcoal** for their cooking fuel.



Access to clean cooking fuel is more widespread in Bangladesh than in Kenya. Bangladesh has made **significant progress in promoting LPG and biogas**, while Kenya faces challenges in expanding clean cooking options

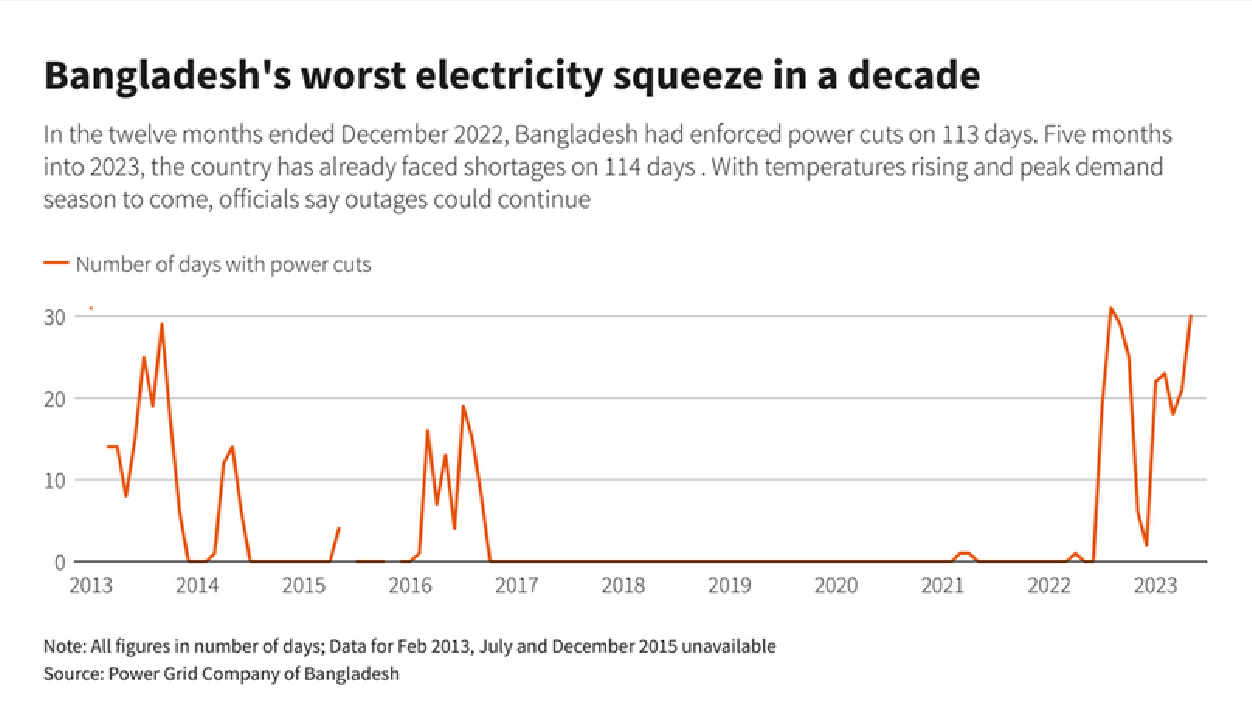


#1 - POWER SHORTAGES
COMPARITIVE ANALYSIS

Ref: www.sciencedirect.com

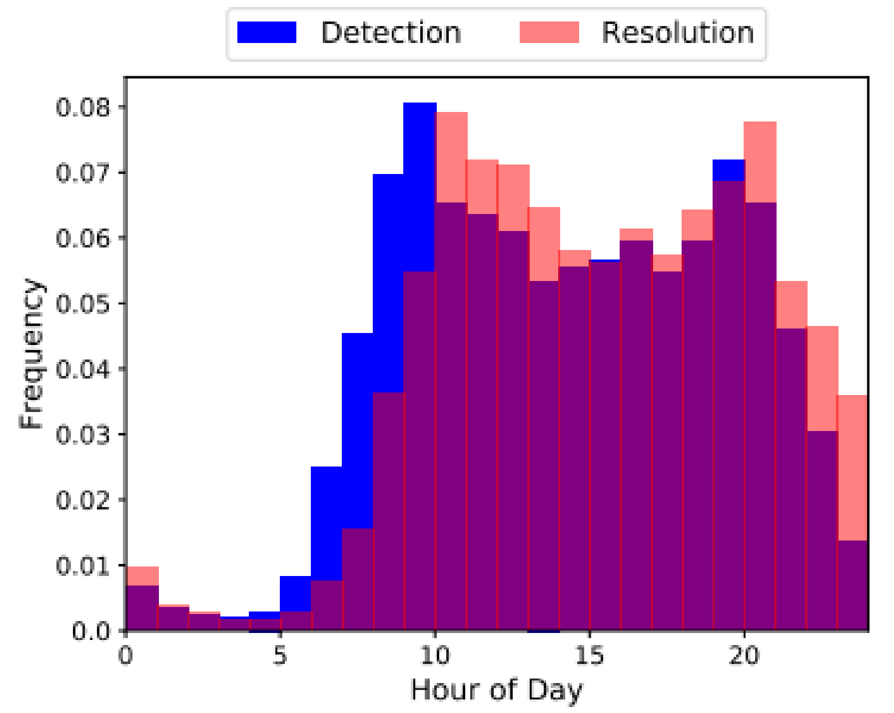
BANGLADESH

- Bangladesh is experiencing a daily shortage of **1000-1500 megawatts** of electricity.
- The shortfall in electricity generation leads to a **‘load shedding’ of 2,000 to 2,500 MW** throughout the country several times a day.
- These power cuts have exacerbated public suffering as the country also tries to combat the impacts of climate change, such as **heat waves**, and tackle soaring temperatures of **38 C to 41 C**.



KENYA

- Kenya has been facing severe power shortages, putting pressure on the country's economic growth and its efforts to improve the day-to-day lives of Kenyans
- Kenya’s installed electricity capacity as of 2021 stood at 2,990 MW, a significant growth from 1,800MW in 2014, but **still low for a country** with a population of **over 50 million**.



(a) Time of day of electricity outages over a year in Kenya.

#2 - PRICE VOLATILITY

COMPARITIVE ANALYSIS

OUTCASTS

KENYA

Average Famliy Income Monthly

171 USD *2021

Average Consumption to Cost per Family

200 UNITS per Month

x 0.15 USD per unit

~ 30 USD per Month

30 USD of 171 USD which nearly accounts **17% of Avg. Income**. By ___ standards cost for electricty should not exceed 10%.

BANGLADESH

Average Famliy Income Monthly

280 USD *2021

Average Consumption to Cost per Family

175 UNITS per Month

x 0.079 USD per unit

~ 13.8 USD per Month

23.4 USD of 280USD which nearly accounts **4.9 % of Avg. Income**. By ___ standards cost for electricty should not exceed 10%.

- The **electricity in Kenya is expensive** due to several factors.
- Legislators and the great majority of customers hold IPPs completely responsible for the high cost of energy, exacerbated by increased retail rates and thermal plant tapping, leading to increased fuel cost charges on customer invoicing.

#3 - HIGH SYSTEM LOSSES
COMPARITIVE ANALYSIS

OUTCASTS

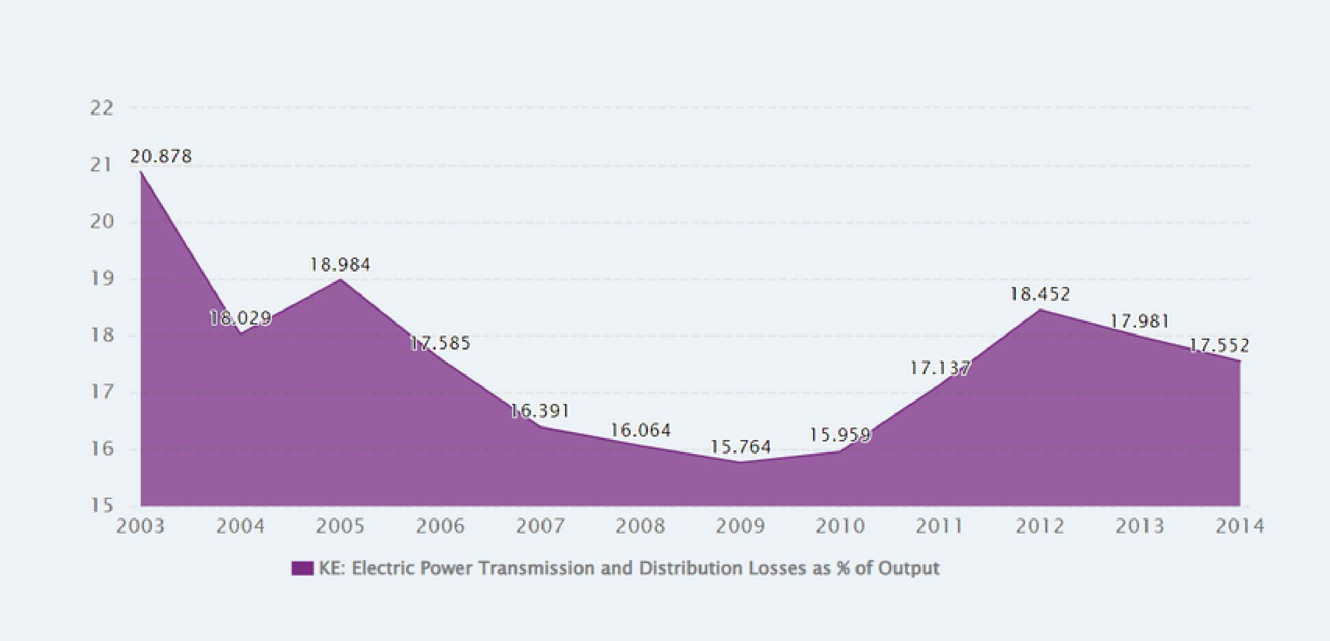
Ref: www.ceicdata.com

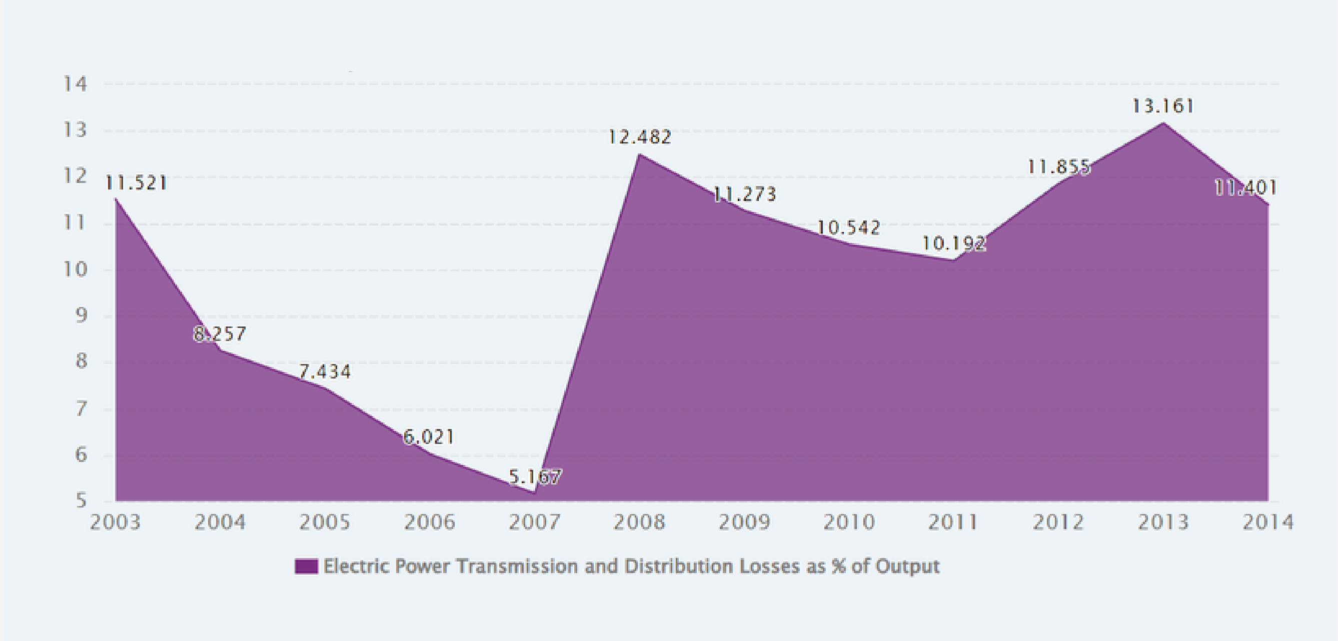
KENYA

- Kenya Power (KP) reported **system losses of 23.49%** between July and December 2022.
- Kenya Power estimates that **each one percent** system loss costs them about **$5.32 million**. In the financial year that ended in June 2021, they shouldered about $ 21.3 million in system losses

BANGLADESH

- System losses in Bangladesh are around **14.02%**. This loss is worth an average of **USD $247 million** per year.
- The total transmission and distribution losses in Bangladesh amount to **one-third of the total generation**.





Kenya experiences greater challenges with **high system losses in its energy sector,** resulting in inefficiencies and unreliability. In contrast, Bangladesh has made strides in reducing losses and improving energy distribution, contributing to a more efficient and dependable electricity supply system.

RESOURCES USED

OUTCASTS

Ref: www.sciencedirect.com

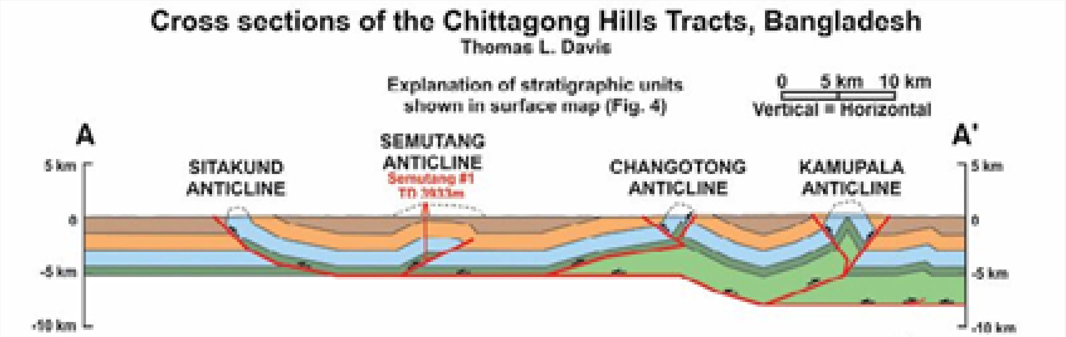
NATURAL GAS

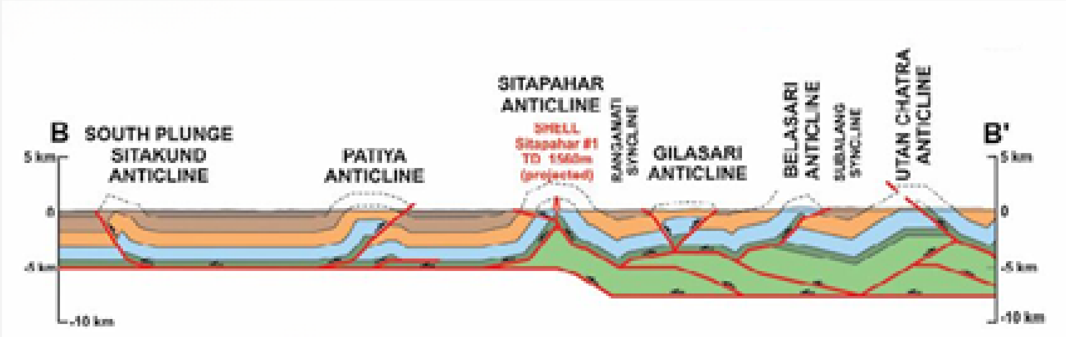
- Bangladesh has large natural gas reserves. As of 2017, Bangladesh had **7.25 trillion cubic feet (Tcf) of proven gas reserves**, which is **7 times its annual consumption**. Bangladesh is the 42nd largest natural gas reserve in the world.

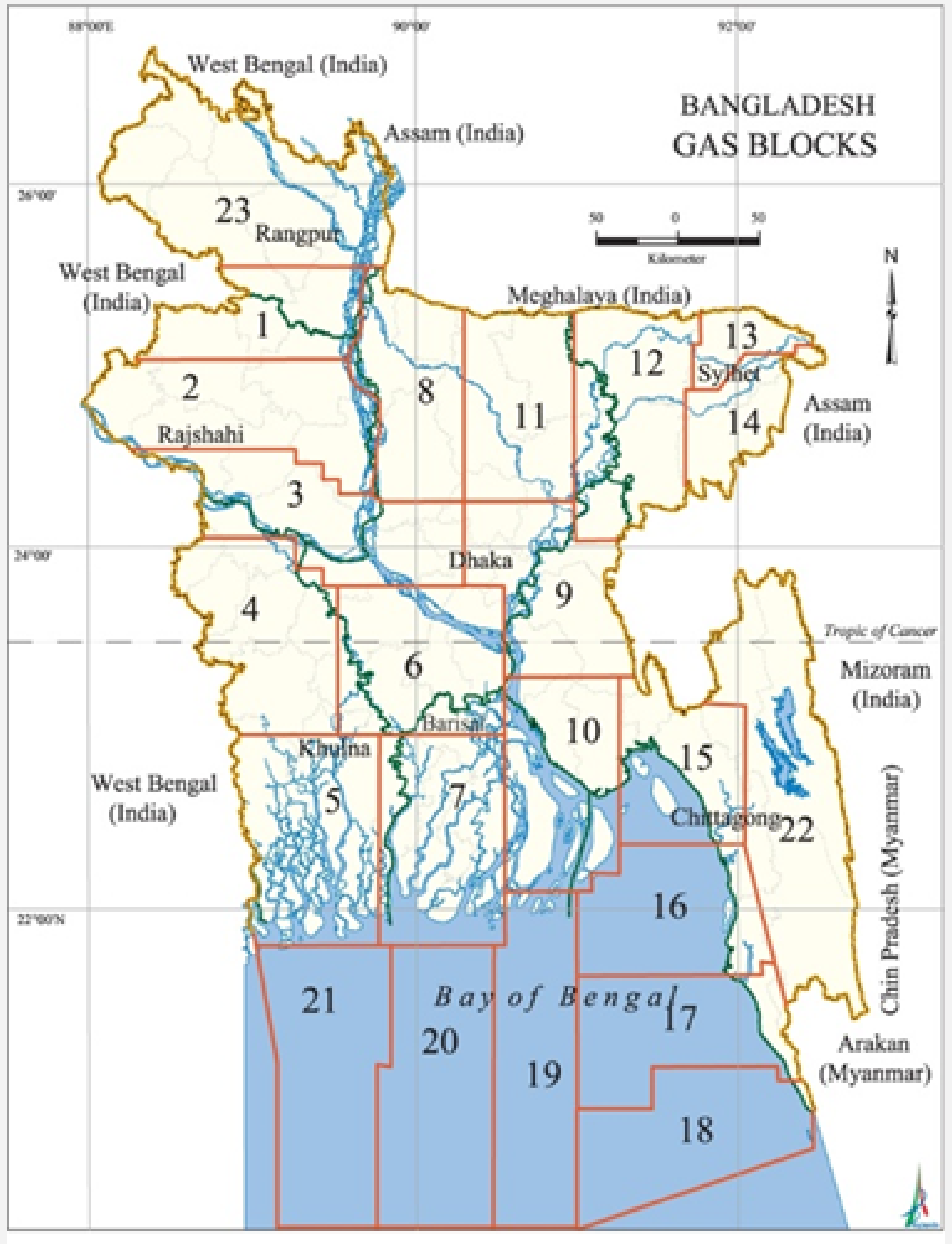
- Bangladesh's power generating sector largely depends on natural gas because it has higher reserves of natural gas compared to other fossil fuel-based energy resources. Commercial energy consumption in Bangladesh comes mostly from natural gas (around 66%).

- Bangladesh is a delta with a **porous and permeable hydrocarbon-bearing sand structure**. Natural gas is largely available in the eastern part of the country, extending from greater Sylhet down to greater Comilla, Noakhali, and Chittagong.

- Bangladesh also has small reserves of oil and coal. In 2021, gas was the **main energy source (59%)**, ahead of oil (18%), biomass (17%), and coal (4%).







BANGLADESH
RESOURCES USED

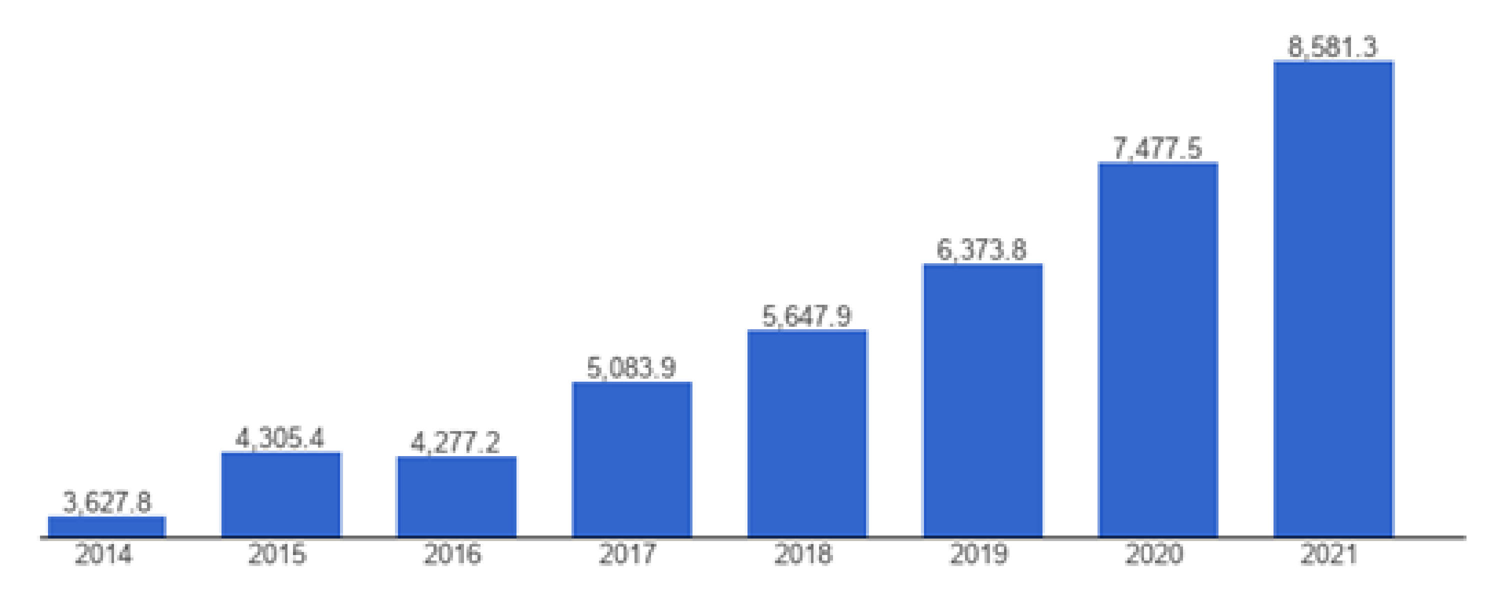
Ref: www.sciencedirect.com

COAL

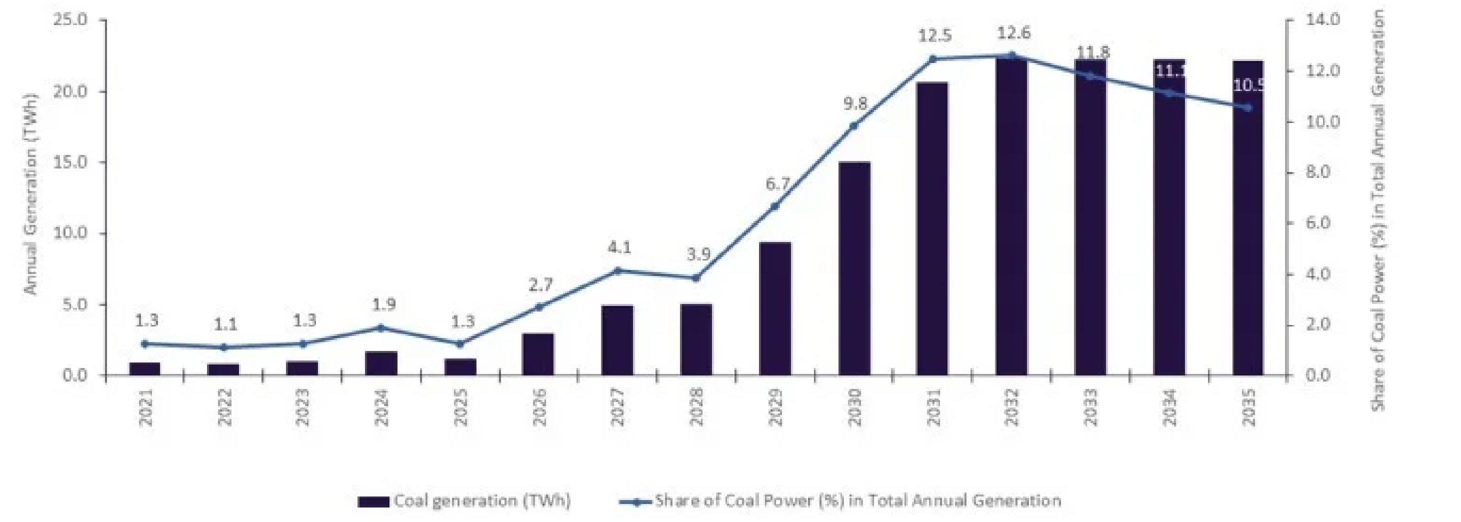
- Bangladesh uses coal for energy generation because it's the **cheapest primary energy source,** and **high-quality coal is abundant** in the country. The government is looking to domestic and imported coal to fuel a significant proportion of its power generation expansion plans.

- Some reasons why Bangladesh uses coal include:
    - Rapid economic growth is stimulating a **rapid increase in electricity demand**.
    - Gas reserves are **declining**.
    - Generating electricity from **gas has become too expensive**.
    - Coal is the cheapest primary energy source.
    - High-quality coal is **abundant in Bangladesh.**
    - The government has undertaken various coal-based mega projects to ensure an affordable and reliable power supply.

- The latest value from 2021 is **8581.32 thousand short tons**. For comparison, the world average in 2021, based on 191 countries is **44475.80 thousand short tons**.



Coal Power in Bangladesh, Annual Generation (YWh) and Share in Annual Generation (%), 2021-2035



Ref: www.ourworldindata.org

BANGLADESH
RESOURCES NOT USED

Ref: Netherlands Enterprise Agency

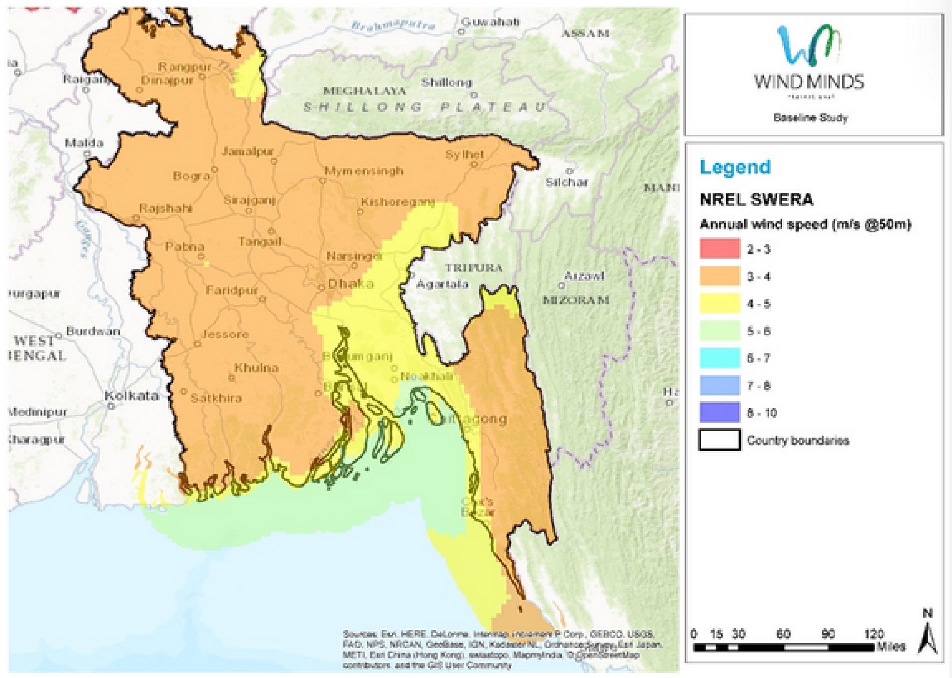
WIND

- Bangladesh has a **potential of over 20,000 MW** of wind energy. The 724 km long coastal region of Bangladesh is suitable for wind power generation. The wind speed in the northeastern parts of Bangladesh is **above 4.5 m/s**, while in the other parts of the country it is around 3.5 m/s.

- Patenga, Feni, Kuakata, Kutubdia, Magnaghat, and Munshigonj have immense potential to produce electricity from wind energy. **If 20% of the total coastal areas are used, about 28,000 MW power output** can be obtained from the wind turbines.

- Wind power is the second-cheapest electricity source for Bangladesh with an estimated **BDT 6 per kWh**.
- But the **challenges** it faces are as follows:
  - Wind speed
  - **Government Support**
  - Technology and expertise
  - **Cost**
- This shows that for every unit, government producers are spending **Tk6.51 more than private producers**.

Figure 3.1 Annual wind speeds in Bangladesh (source: NREL, 2007)



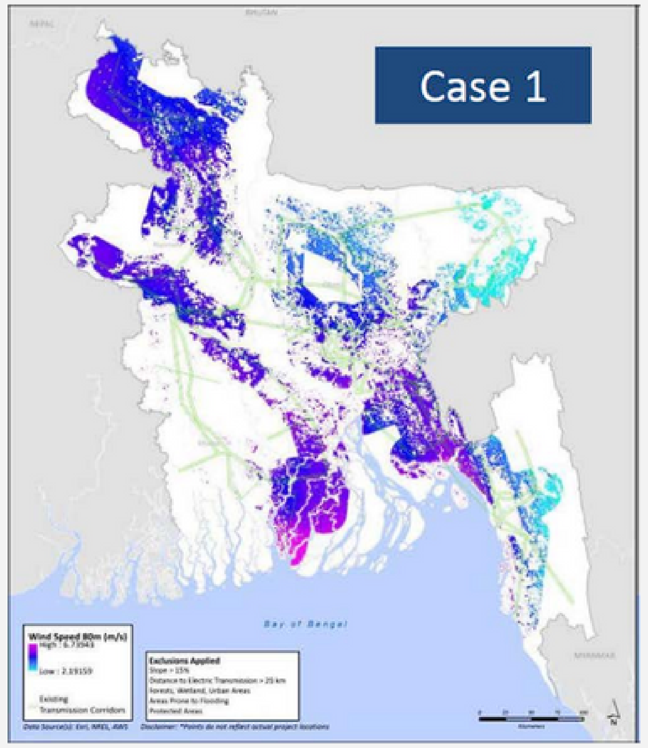
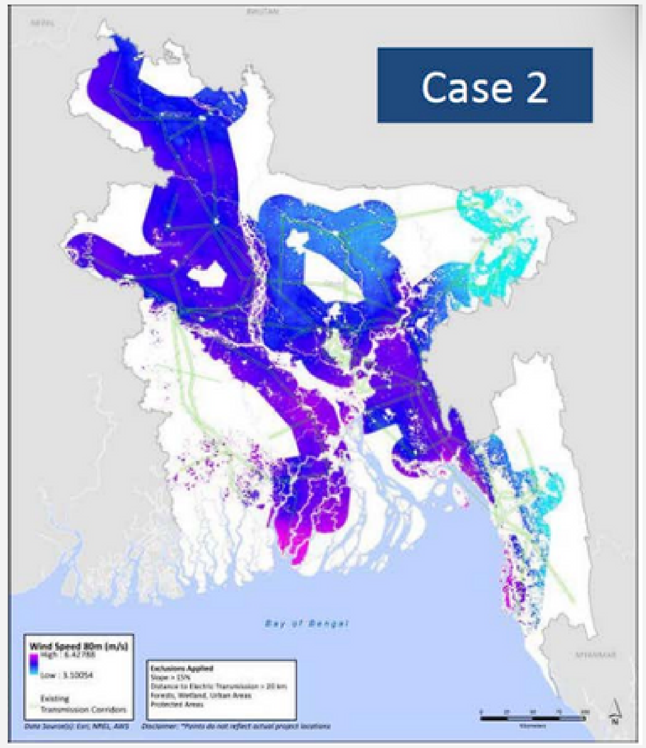


Table 3.1 Result of assessment within SREP (Case 1 excl. flood prone land, Case 2 is included)

	Case One		Case Two	
	20-25% Capacity Factor	25-30% Capacity Factor	20-25% Capacity Factor	25-30% Capacity Factor
Buildable MW	624	13	996	37



RESOURCES NOT USED

OUTCASTS

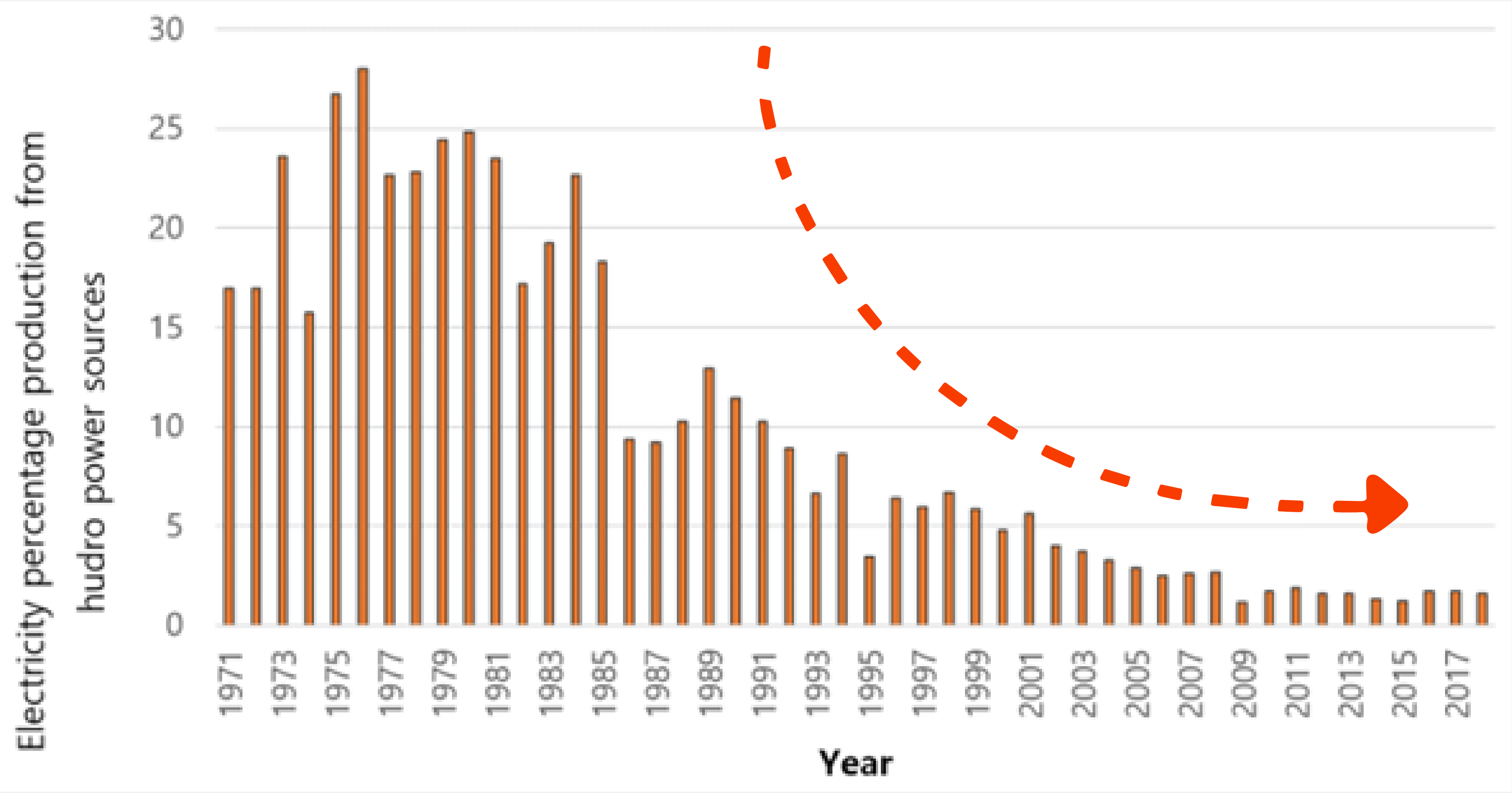
Ref: www.sciencedirect.com

HYDROPOWER

- Bangladesh has limited hydropower potential due to its geography and topography. **The country has many rivers, but lacks high head and high flow rates**.

- Bangladesh is looking to expand its hydropower capacity to meet future energy demands from industry. The country's **only hydropower plant is the Karnafuli Hydropower Station**, located in Kaptai, **about 50 km from the port city of Chittagong.**

- Challenges:
  - Growing power generation prices
  - High initial capital
  - Lack of investors
  - Competition from fossil fuels
  - Fewer subsidies compared to traditional fuel
  - Erratic weather
  - Low plant efficiency
  - Can have an environmental impact, displace people, be expensive, and be unsafe.



MINOR PROBLEMS BREIFLY EXAPLAINED

ILLITERACY

- 2019 Report Says, literacy among **men is 85** % and for **women is 79.8**%.
- Almost **15 percent** men don't even know to how to read/write and can't understand a statement in any language.

UNEMPLOYMENT

- Kenya unemployment rate is **5.5** % in 2022.

CAUSES :

- High Inflation Rate.
- Population Growth.
- Urbanization.

LOW HOUSEHOLD INCOME

- Average monthly income in Kenya is **$133.8**.
- According to the World Bank Blogs, An average Low Middle Class Income should be around **$1040**.

INCOME GAP

- The **richest 10**% of people in Kenya earned on average **23 times** more than the **poorest 10%.**

HEALTH CARE

- Challenges :
  - Setback in Supply chain.
  - Understaffed Hospitals.
  - A lot behind in using new Technologies.

POLLUTION

- Kenya is the **83rd most polluted** country in 2023.
- The WHO estimates that approximately **19,000 people die** in Kenya due to air pollution.

POPULATION GROWTH

- The **fertility rate** should be around **2.1** so that the country's population is stable.
- Kenya's fertility rate is **3.40**

SANITATION

- **9.9 million** people drink directly from **contaminated water**.
- **25% people** dont have handwash/soap to wash their hands.

MINOR PROBLEMS BREIFLY EXAPLAINED

ILLITERACY

- According to the Bangladesh Bureau of Statistics (BBS), **25.34%** of the population in Bangladesh is illiterate. This equates to **42 million people**
- The literacy rate among **males stand at 76.56%,** compared to **72.82% among females.**

UNEMPLOYMENT

- Bangladesh unemployment rate is **4.7** % in 2022.

CAUSES :

- Seasonal Agriculture,
- Rapid Population Growth.
- Demand for skilled labor

LOW HOUSEHOLD INCOME

- Average monthly income in Bangladesh is **$294.08**.
- According to the World Bank Blogs, An average Low Middle Class Income should be around **$1040**.

INCOME GAP

- The upper class in Bangladesh comprises only **1-3%** of the population, but holds more than **25%** of the nation's wealth.
- The **Gini coefficient**, rose to **0.499** in 2022,

HEALTH CARE

- Challenges :
  - Poor Governance.
  - Weak Public health communication.
  - Scarcity of drugs, ambulances, and medical equipment

POLLUTION

- Air pollution was responsible for the death of 173,500 people in 2019 in Bangladesh.
- Residents of Bangladesh lose an average of 6.8 years of life from bad air.

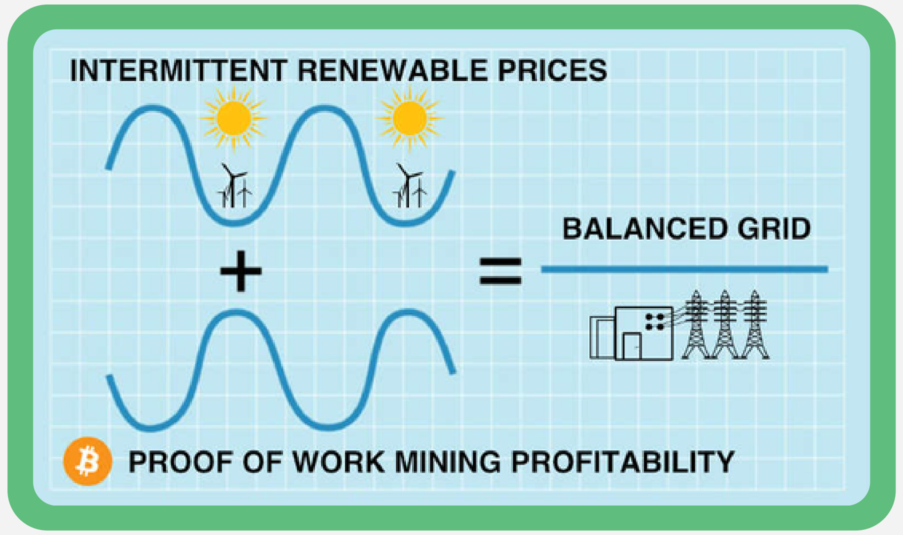
CLIMATE CHANGE POLICIES

- In June, an estimated **7.2 million** people in Bangladesh were affected by record level flooding in the northeast.

SANITATION

- **68 million people** people use **contaminated water.**
- **75.4 million** people in Bangladesh do not have a decent toilet of their own.

UNIQUE CHALLENGES
KENYA

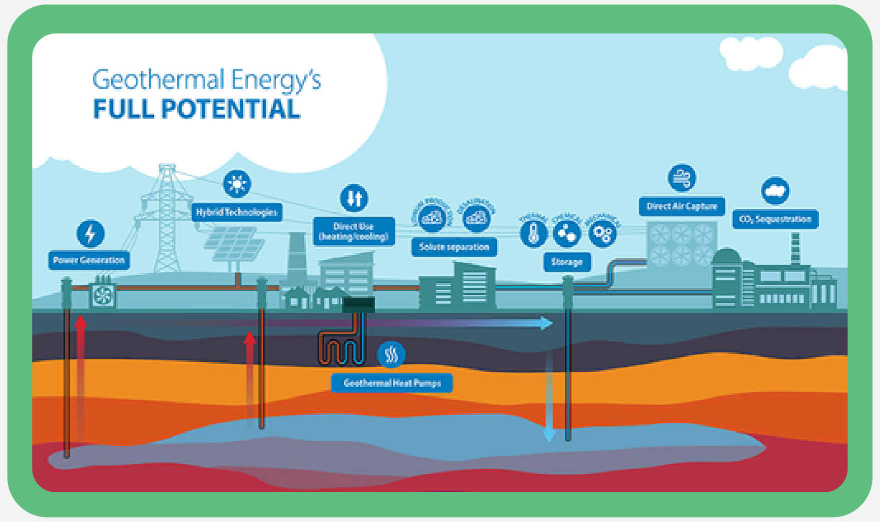


BALANCING INTERMITTENT RENEWABLES

Kenya's energy landscape is characterized by a substantial dependence on intermittent renewable sources, primarily wind and solar. The unique challenge lies in effectively managing the variability of these sources to maintain a stable and reliable power supply. This **involves sophisticated grid management, energy storage solutions, and demand-side management** strategies to ensure a seamless transition to renewable energy while meeting the constant energy demands of a growing economy.

GEOTHERMAL POTENTIAL AND INVESTMENT

Kenya is home to one of the world's most extensive geothermal resources, presenting a unique opportunity for clean energy generation. However, harnessing this potential requires drilling deep geothermal wells and effectively managing subsurface resources. It's a challenge that demands significant investments, specialized geothermal expertise, and careful resource management to unlock the **full potential of this sustainable energy source**, while ensuring its long-term viability.



OVERVIEW

KENYA

EXPECTED vs REALITY

	Planned Status by 2030	Reality
Generation Capacity	Targeted **5,000 MW capacity**, primarily from geothermal, wind, and solar.	Achieved around **2,980 MW**, with a significant expansion in geothermal but falling short of the ambitious target.
Cooking Fuels	Transition from **traditional biomass** to cleaner fuels like **biogas** and **improved cookstoves.**	Transition made progress, but significant biomass **use remained** in 2021, with specific figures varying by region.
Access to Electricity	Aiming for **70% grid-based access**, with off-grid solutions for the rest.	Urban areas saw progress, but **disparities remained in remote regions.** Specifically in 2021 access was moderately low.
Renewable Energy	Expanding the use of **renewables** (wind, solar, geothermal) for sustainability.	Significant progress with **increased geothermal**, wind, and solar capacity integrated into the energy mix.

KENYA

MAJOR ENERGY CHALLENGES

OUTCASTS

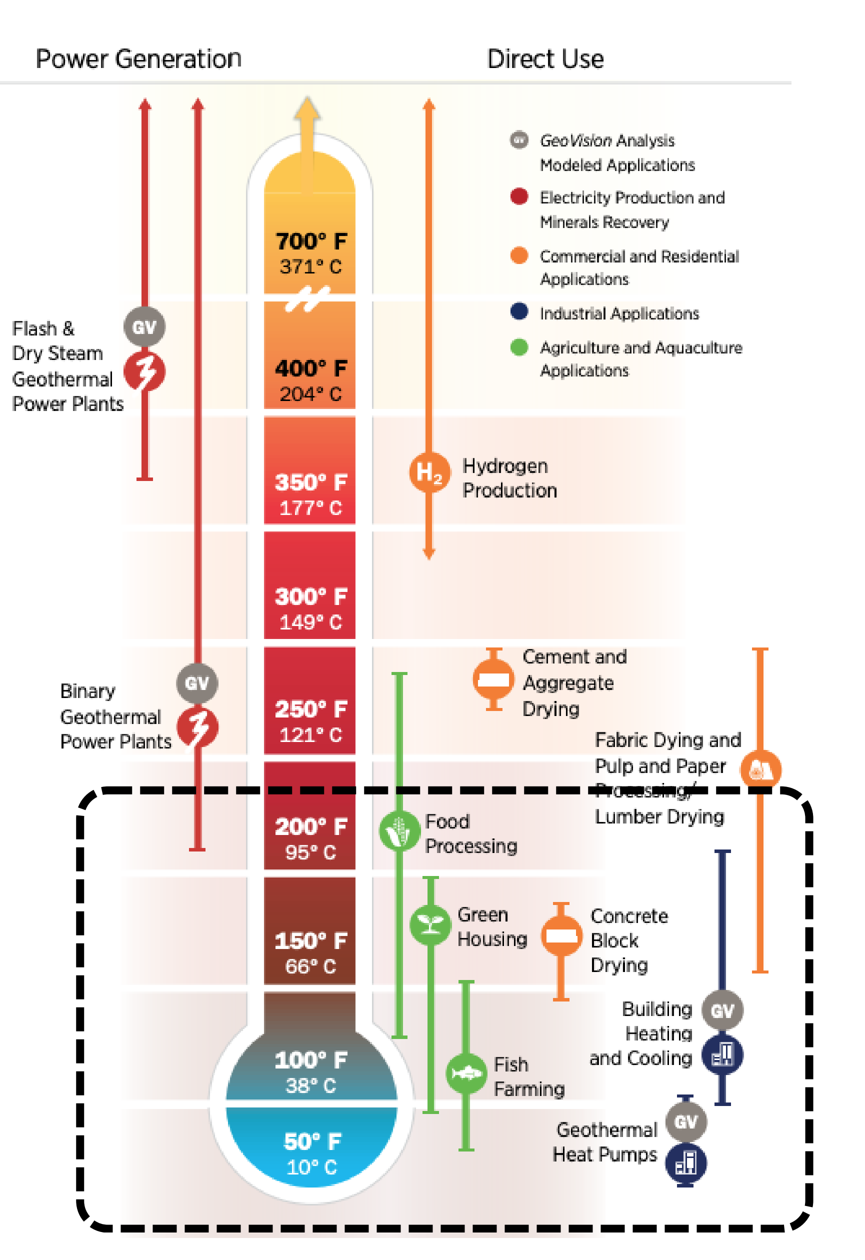
LIMITED USE OF **GEOTHERMAL GENERATION** FOR **ELECTRICTY** ONLY

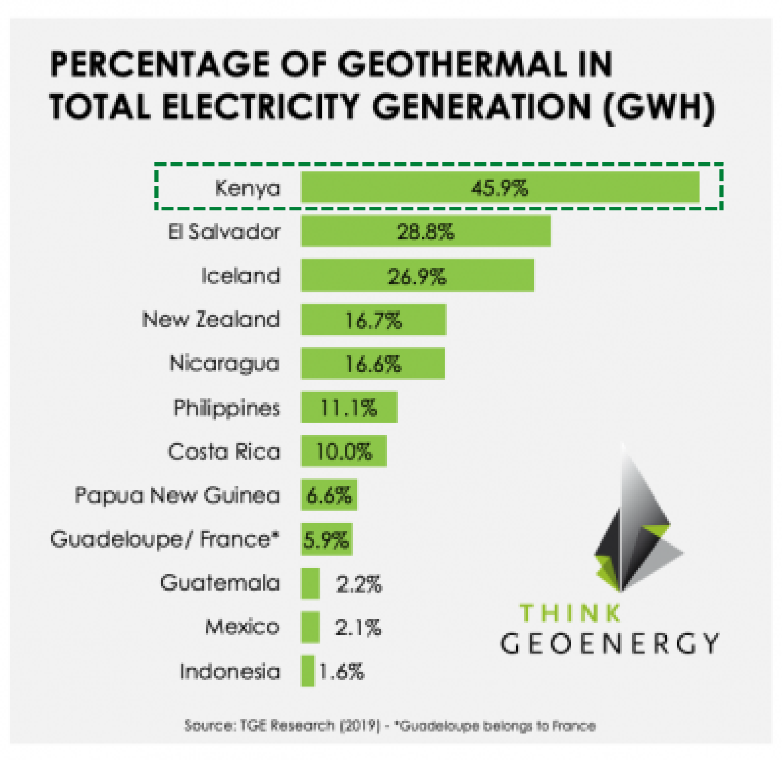
- **Underutilization and major use of Geothermal for Electricity:** Geothermal accounted for around **45%** of Kenya's electricity generation in 2021. However, **Kenya's geothermal potential exceeds 10,000 MW,** indicating significant untapped capacity.

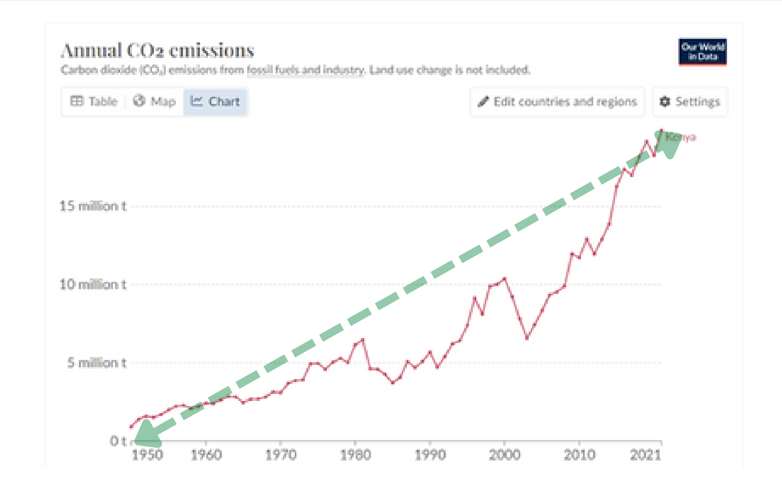
- **Untapped Potential for Geothermal Heating/Cooling**: Geothermal's potential for residential **heating and cooling** remains underexplored.

- **CO2 Sequestration Challenges:** Geothermal energy production in Kenya offers opportunities for **CO2 sequestration**

- **Limited Use of Geothermal for Goods Storage**: Geothermal's potential for **cold storage in agriculture** and other sectors should be compiled with its use for electricity generation.







OUTCASTS

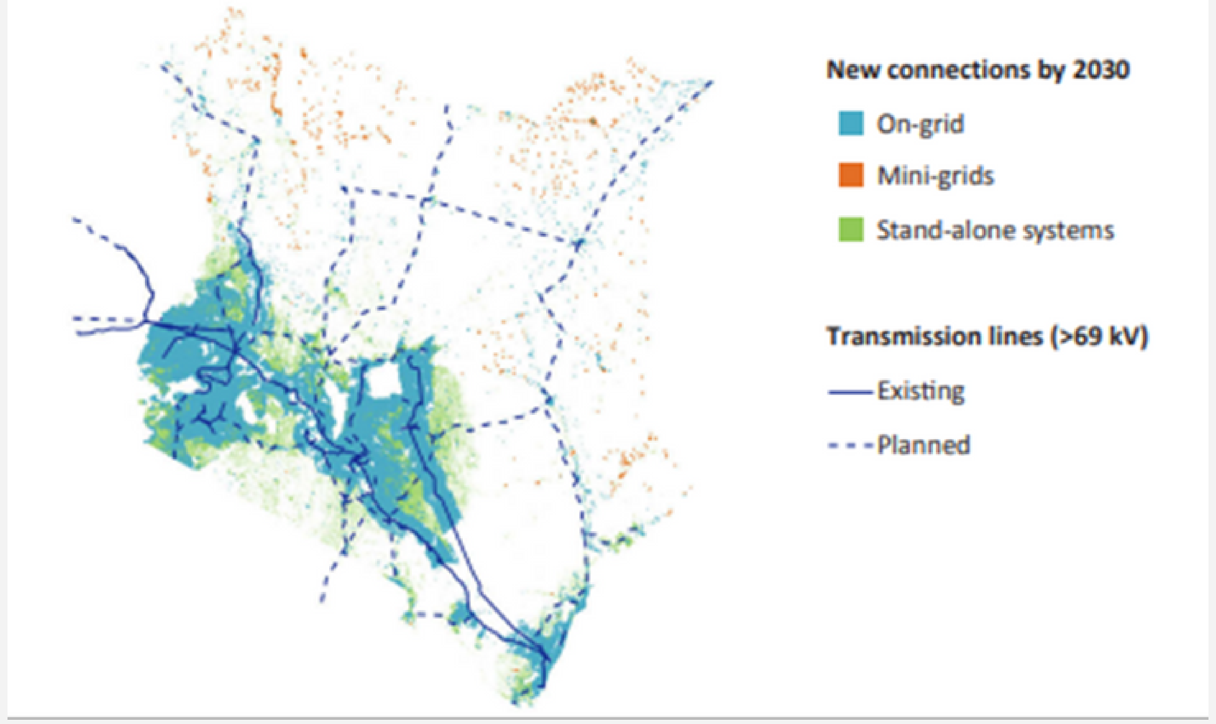
Ref: www.tbsnews.net

ELECTRICTY AVAILABLITY

- The energy sector in Kenya has been facing several challenges in recent years, with power distribution being a significant area of concern. **The high cost of electricity in the country** has been a key issue for many consumers, with prices being significantly higher than in other African countries.

- One of the major challenges in the distribution of electricity in Kenya is the high rate of technical losses. Technical losses refer to power losses that occur due to inefficient distribution systems and equipment. In Kenya, **technical losses account for up to 18%** of the total power generated, which is a significant amount. These losses result from **outdated equipment**, **poor maintenance practices**, and **inadequate investment** in the distribution network.

- Ensuring the quality control of transformers is essential for rural electrification. According to the **Energy Regulatory Commission (ERC)**, in 2019, **electrical faults caused 59 fire incidents**, resulting in damage to property and loss of life. **Poor quality transformers** are a significant risk factor for electrical fires, and there is a need for a robust quality control system to ensure that transformers meet the required standards.



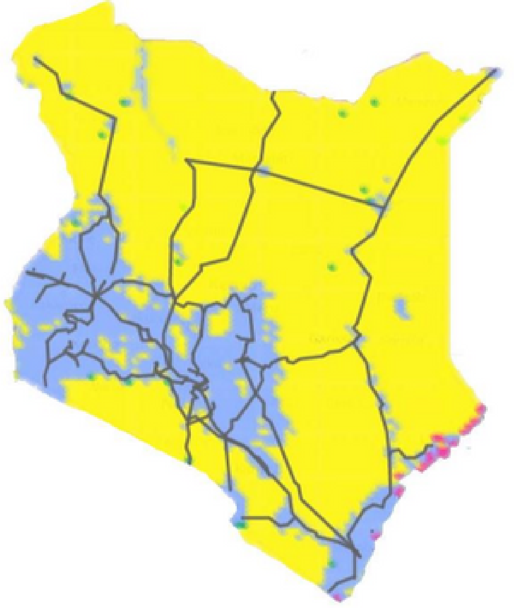


Figure 8 – OnSSET map with the optimal split of household electricity solutions in the Vision-scenario

Table 2 – Comparison of the cost optimal split of electricity solutions in Vision and BAU scenarios

Scenario:	Vision	BAU
National grid	93,18%	90,37%
Standalone diesel	0,009%	0,014%
Standalone PV	6,53%	9,57%
Mini grid diesel	0%	0%
Mini grid PV	0%	0%
Mini grid wind	0,11%	0%
Mini grid hydro	0,17%	0,05%

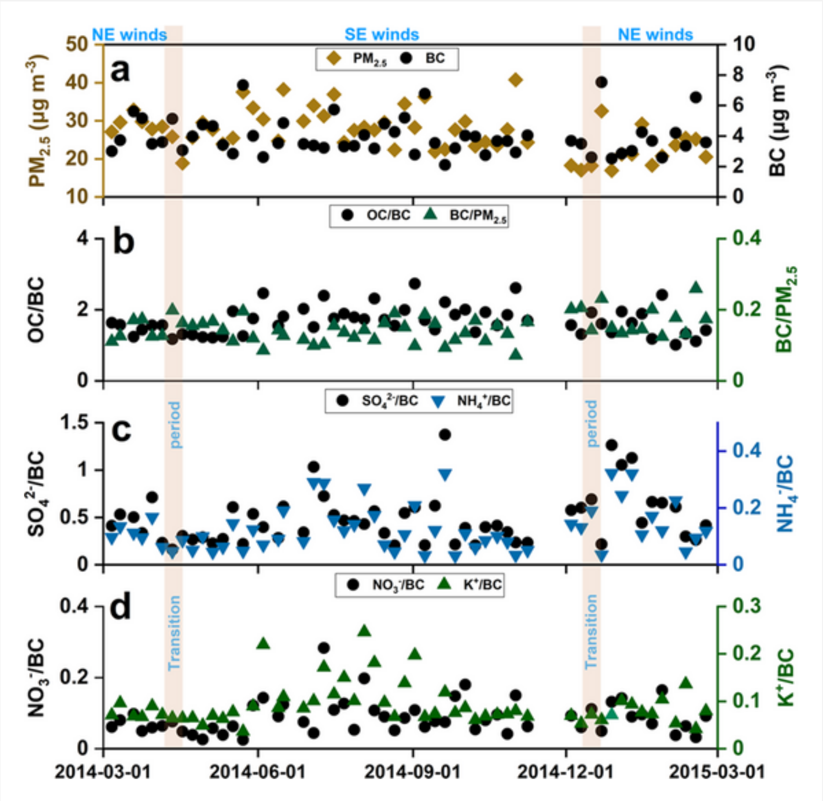
KENYA
MAJOR ENERGY CHALLENGES

OUTCASTS

Ref: www.tbsnews.net

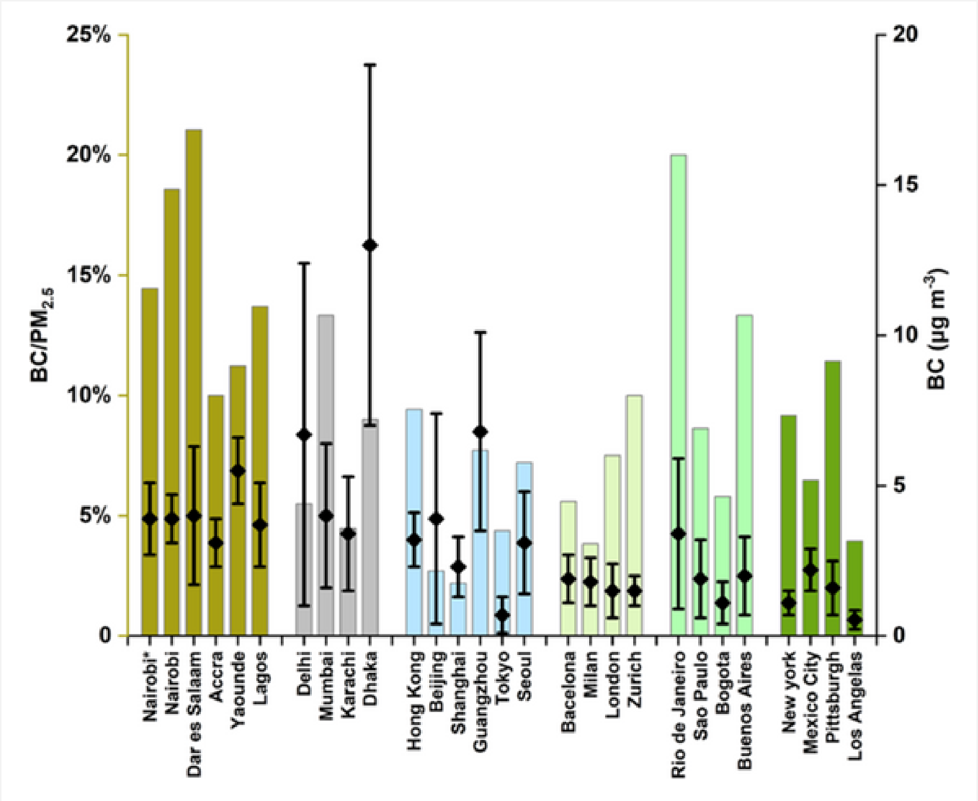
Black Carbon Emission

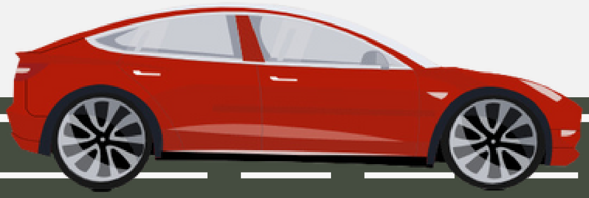
- Black carbon (BC) emissions are a **major contributor to air pollution in Nairobi**, Kenya. BC is a sooty black material that is emitted from gas and diesel engines, coal-fired power plants, and other sources that burn fossil fuel. It comprises a significant portion of particulate matter (PM).
- In Nairobi, the central business district recorded 11-hour average daytime BC concentrations in the **range 20–42 μg m−3**. The main highways feeding into Nairobi recorded BC levels of **17–79 μg m−3**. These data include the **highest multi-hour BC concentrations ever reported in Africa**.
- Fossil fuel combustion emissions are a **dominant source of black carbon** throughout the year **(85 ± 3%).**



Kenya grapples with black carbon emissions, predominantly **originating from inefficient cookstoves and diesel engines**. These emissions not only accelerate climate change but also pose **severe health risks**.

Initiatives are underway to **encourage cleaner technologies and mitigate** black carbon's adverse impacts on the environment and public health.





ENERGY OVERVIEW | COMPARITIVE ANALYSIS | PHASE PLAN 01 - 02 - 03 | IMPACT ON KENYA | FEASIBLITY IN BANGLADESH | IF OUR PLAN GOES SOUTH | CONCLUSION

PHASE PLAN
01 - 02 - 03

KENYA
PHASE - 01 - PLAN

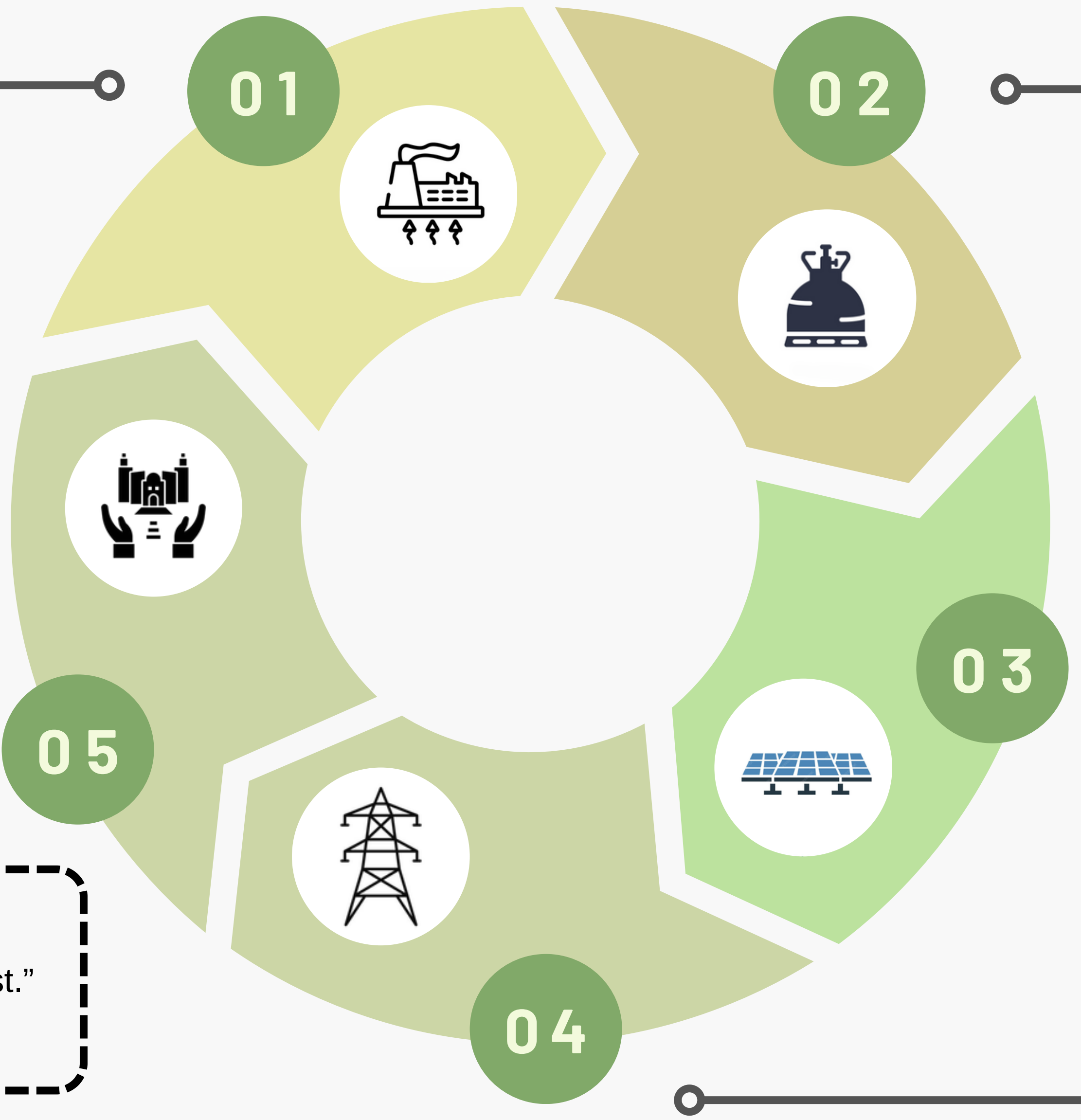
2025 - 2027 | 2028 - 2031 | 2032 - 2035

Exploration and Analysis of Geothermal Wells

"Feel the need, need for speed "in Geothermal and its vast application"

Company Setup

Setup Commercial connections to cut down on costs, and have better overall control on the project.



Clean Cooking Fuel

Bio Gas ⇌ **Electric Stove**

Offgrid Solar Plants Setup

Directly target electricity accessibility using off-grid solar plants.

Expanding the Grid

Expand the grid and its quality to improve transmission loss and endure more load.

"It is time for a sustainable energy policy which puts consumers, the environment, human health, and peace first."
-Dennis Kuchinich

CLEAN COOKING FUEL

OUTCASTS

CURRENT SCENARIO

In Kenya, an **estimated 90%** of the population use traditional biomass fuels, such as firewood and charcoal, for cooking.

Despite the government's efforts, the transition to clean cooking has been slow. In 2019, **only 12% of Kenyan households were using clean cooking fuels**, such as liquefied petroleum gas (LPG) and biogas.

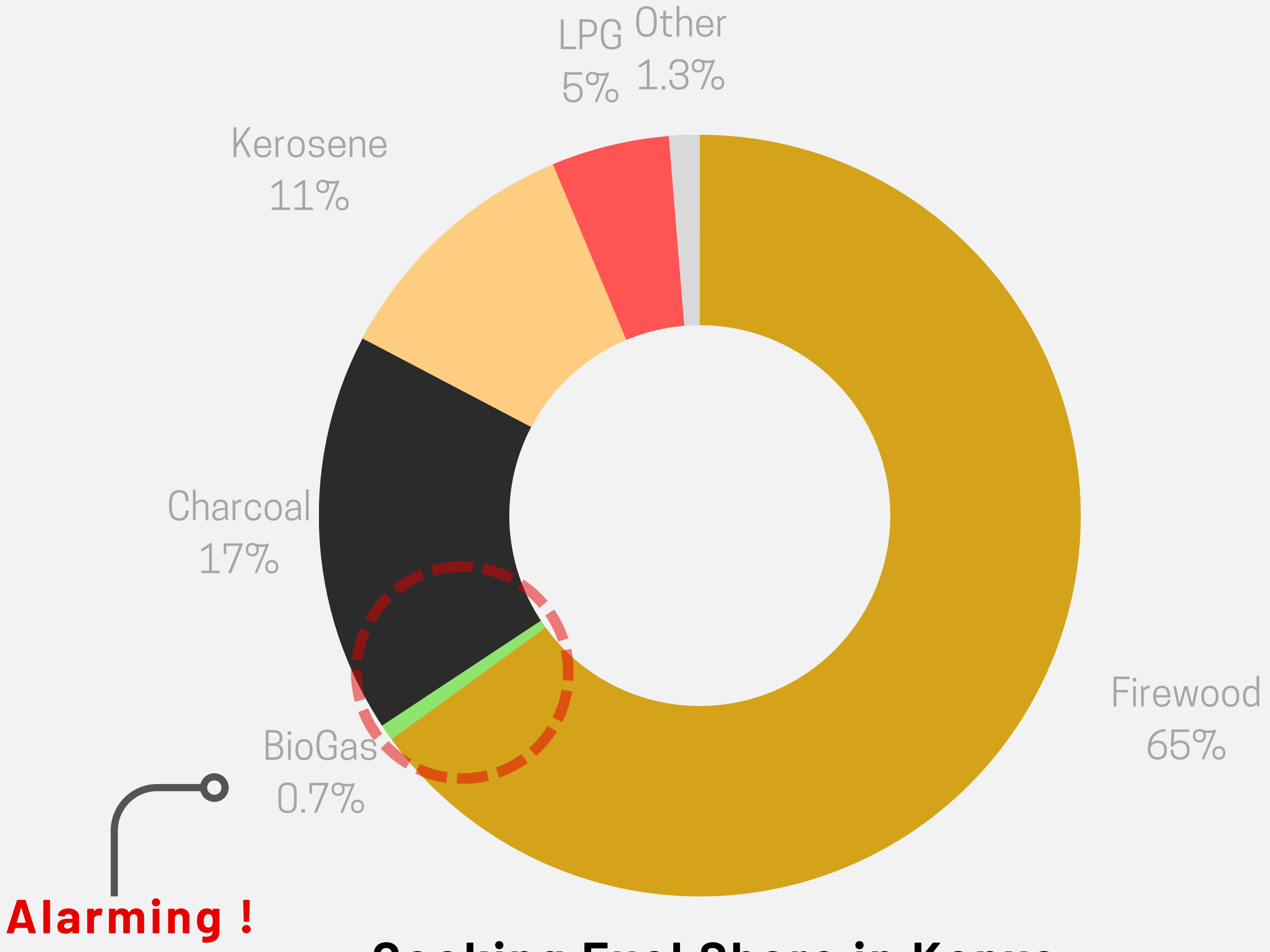
GOVERMENTS EFFORT?

The Kenyan government has recognized the need to transition to cleaner cooking fuels and technologies. **In 2012**, the government **launched the National Clean Cooking Strategy**, which aims to increase access to clean cooking fuels and technologies to 100% of the population by 2030.

CHALLENGES FOR ESTABLISHMENT ?

- **High cost**: Clean cooking fuel is often more expensive than traditional biomass fuels.
- **Lack of awareness**: Many people are not aware of the benefits of clean cooking fuel or the risks of using traditional biomass fuels.
- **Limited access**: Clean cooking fuel is not always available in rural areas.

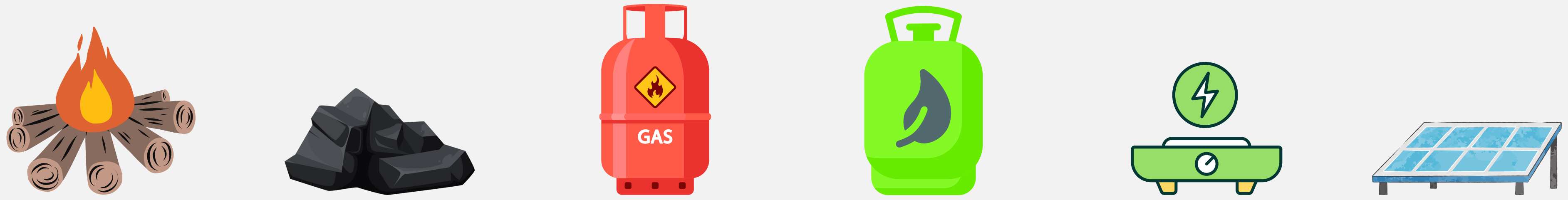
Indoor air pollution from cooking with traditional biomass fuels is estimated to cause over **20,000 deaths** each year in Kenya.



Cooking Fuel Share in Kenya

ALTERANTIVES FOR COOKING FUEL

OUTCASTS



	TRADITIONAL STOVE		ADVANCED STOVE		ELECTRIC STOVE	SOLAR COOKER
FUEL TYPE	**FIREWOOD FUEL**	**CHARCOAL**	**LPG**	**BIOGAS**	**ELECTRICITY**	**SOLAR ENERGY**
COOK STOVE (COST)	Jiko Kisasa 250-500 Ksh	Kenya ceramic Jiko: 500-1,000 Ksh	LPG stove 3,500-7,000 Ksh	Basic biogas unit 50,000- 80,000 Ksh	Electric Stove 3,500Ksh	Off Grid 10,000 - 20,000 Ksh
FUEL COST	70 Ksh/ bundle	40 Ksh/ Kg	133-200 Ksh/kg	0 Ksh	19.69 Ksh/ kWh	0 Ksh
FUEL HEAT VALUE	16 MJ/ kg	29 MJ/ Kg	46 MJ/ kg	50 MJ/ kg	3.6 MJ/ kWh	
COOK STOVE EFFICIENCY	28%	20%-50%	55%	N/A	80%	40-60%
POLLUTION	HIGH MODERATE	HIGH MODERATE	LOW	NONE	LOW	NONE
IMPACT ON HEALTH	Air pollution causes lung, heart, cancer	Charcoal cleaner than firewood but dirtier than transitional fuels.	None	None	None	Reduces exposure to indoor air pollution
IMPACT ON ENVIRONMENT	Charcoal contributes 18% of GHG emissions, and is consumed at 741 kg/year per capita in rural areas.	Charcoal production inefficient and polluting, 156 kg per capita.	LPG stoves emit 50 times less pollutants than biomass burning stoves.	Biogas, milk, and cow dung from 2-4 cows, water access for farmers.	Electricity in Kenya is expensive, and very limited of households have access.	Reduces deforestation and greenhouse gas emissions.

- Kenya is witnessing a shift towards various alternative cooking fuels, driven by the need to reduce the environmental and health impacts of traditional biomass usage. **Liquid Petroleum Gas (LPG) has gained popularity due to its convenience and cleaner combustion.**
- **Biogas, produced from organic waste, offers a sustainable and eco-friendly option.** Electric induction stoves are becoming more accessible, utilizing electricity as a clean energy source.
- These alternatives collectively aim to enhance access to cleaner and more sustainable cooking methods for the Kenyan population.

DESIGN SETUP - BIOGAS
SITE SELECTION OF PLANT

OUTCASTS

FOR INDUSTRIAL AREA

SUGARCANE INDUSTRY

Biogas production from **sugarcane waste**, also known as **bagasse**, holds significant potential for energy generation due to several key factors:

- Abundant **Feedstock Supply**
- **Efficient Waste** Utilization
- **Low Environmental** Impact
- **Versatile** Energy Output
- **Reduces Greenhouse** Gas Emissions
- Energy **Independence**

INDUSTRIAL DIGESTOR

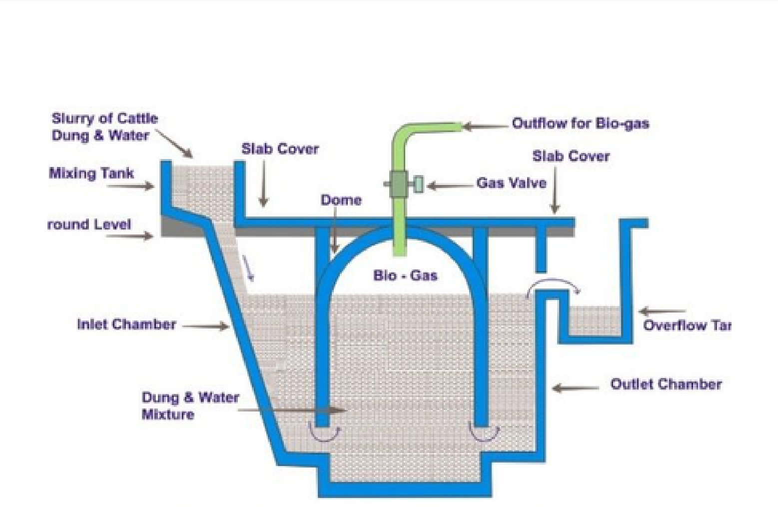
Modern biogas technology designs are typically above-ground, with underground structures also available. In Europe, 95% of gas use is a thermo-power unit, producing electricity, grid power, and heat for various uses. Dry fermentation can process various organic materials, including waste paper, grass clippings, leftover food, sewage, and animal waste.

FOR RURAL AREA

FIXED DOME SIZE

Fixed-Dome Size type Biogas plant will be the best alternative due to its following characteristics:

- Subterranean building
- Protecting against the winter cold and conserving space.
- The cost of constructing fixed-dome AD plants are relatively low.



Fixed Dome type Bio-gas Plant

MORE ABOUT FIXED SIZE

Fixed dome plants offer low initial costs, long lifespan, compact design, space savings, and insulation. They create local employment and are well-constructed underground, saving space and protecting the digester from temperature changes.

WHY ELECTRIC STOVE OVER CNG ?

OUTCASTS

OVERVIEW

- The usage of electric stoves in Kenya is relatively low, with only about 1% of households using them for cooking.Despite these challenges, there is a growing interest in electric stoves in Kenya. The government is promoting the use of electric stoves as part of its efforts to improve air quality and reduce greenhouse gas emissions. Additionally, a number of private companies are developing and manufacturing affordable electric stoves for the Kenyan market.

WHY IT IS BETTER

- An electric stove can be a better choice than CNG (Compressed Natural Gas) for cooking in Kenya for several reasons:
- Accessibility: Electricity is more widely available in Kenya than CNG infrastructure, making electric stoves more accessible to the population.
- Environmental Impact: Electric stoves are often considered more environmentally friendly as they produce zero direct emissions at the point of use, while CNG is a fossil fuel and produces greenhouse gases when burned.
- Energy Efficiency: Electric stoves can be more energy-efficient as they convert a higher percentage of energy into usable heat compared to CNG stoves.
- Safety: Electric stoves are generally considered safer as there is no risk of gas leaks or explosions associated with CNG.
- Convenience: Electric stoves are easy to install and use, whereas setting up CNG infrastructure can be more complex and costly.

OPPORTUNITIES FOR BIO - GAS

OUTCASTS

POTENTIAL ZONES

Biogas plants are mainly to be setup in rural areas, where the electricity accessibility is less/ the national grid is not available nearby.

REASON ?

Biogas is mainly focused in rural areas as more bio-degradable waste will be easily available in that region.

FOR OTHER REGIONS?

For other regions, the electricity is accessible, causing electricity stove to be a better option. Thus, in those region, no. of biogas plant setup will be less.

FINANCE MODEL - DOME

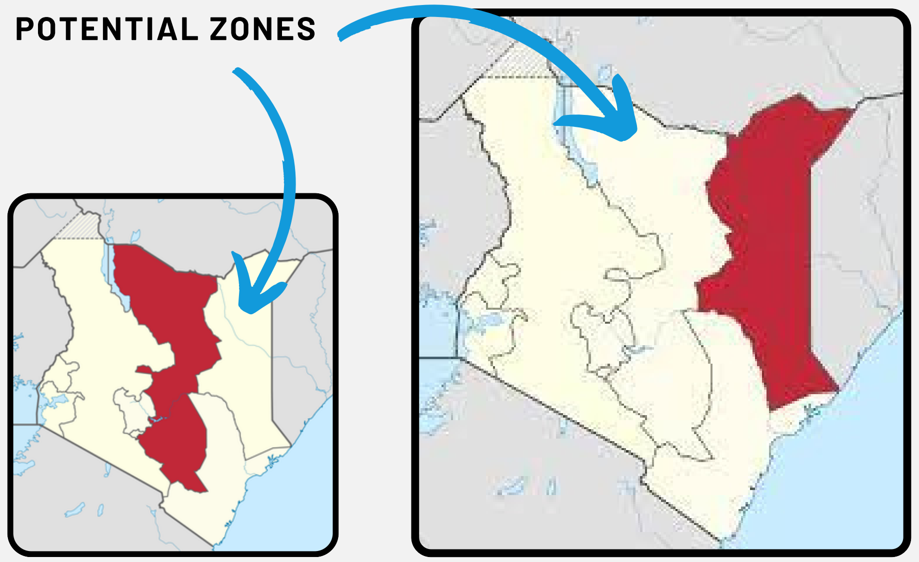
FINANCIAL FACTORS

Lets consider,

1 community = 1000 houses.

Therefore we need **578 plants** in North Eastern State of Kenya

POTENTIAL ZONES



Target Population

2.5 million (578,703 families)

Rural Kenya

IMPLEMENTATION

1 households requires **0.8 -1.1 kWh** (Cooking)

Rural Population - **2.5 million (578,703 families)**

NET COST FOR INSTALLATION

Approximately **10,000 USD** for one power plants.

Almost **580 Plants * Setup Cost** = **5,800,000 USD**

* Other Costs for Smooth Opertaion = **1000 – 2000** $ for **1 Plant**
* For 580 plants, other costs : **580,000 – 1,160,000** $ per year.

ENERGY FACTORS

To be remembered,

1 metric cube of biogas gives out **6 kWh (**only **2 kWh** usuable**)**

1 Plant for 1 Community

Electrcity Generation of **1 biogas plant** = **~ 1200 kWh** (approx)

Here the finances is shown only for the eastern province of Kenya.
The total Energy and Revenue can be predicted further.

ANALYSIS

Energy Demand = **Max (1100 kWh)**

Energy Generation = **~1200 Kwh**

Cooking Demand Fullfilled

OUTCASTS

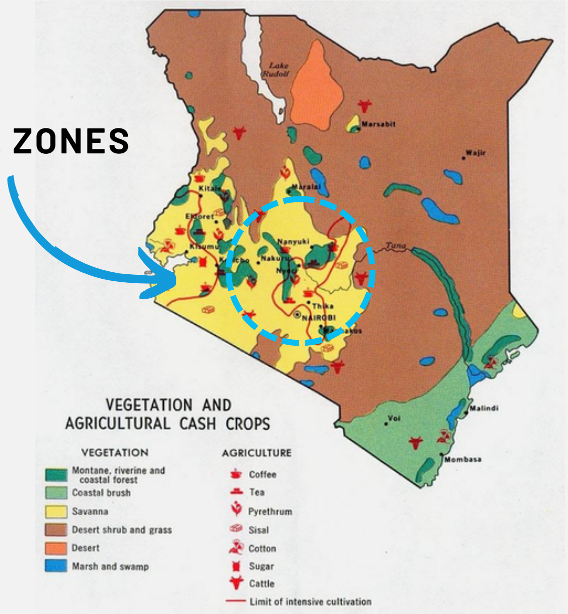
FINANCE MODEL - INDUSTRIAL DIGESTOR

FINANCIAL FACTORS

Average cost of electricity for sugar factories - **USD 0.10 per kWh**.

Our Bio Gas Plant - **USD 0.05 per kWh**. i.e. **save USD 0.05 per kWh** on electricity costs.

POTENTIAL ZONES



Since we are setting up our Bio Gas Plant at the SugarCane Industries' Site, we may only charge half of the original cost of Electricity

IMPLEMENTATION

Plant Capacity - 1 MW
Average Sugarcane factories consumes - **100 - 150 kWh / ton of cane**

NET COST FOR INSTALLATION

- Construction of a biogas plant with an industrial digester: **USD 5 million**
- Connection of the biogas plant to the sugarcane factory's power grid: **USD 1 million**
- Total project cost: **USD 6 million**

ENERGY FACTORS

- Electricity cost saved = Average Consumption * Save
- 5 USD/ton of cane = 100 ton of cane * 0.05 USD/kWh
- Therefore for **10,000 tone of cane** the factory can save **50,000 USD.**

Reason For Priortisng SugarCane and Coffee Industry
The **waste residue generated by these industry**, works as the most efficient fuel for BioGas Generation

ROI CALCULATIONS

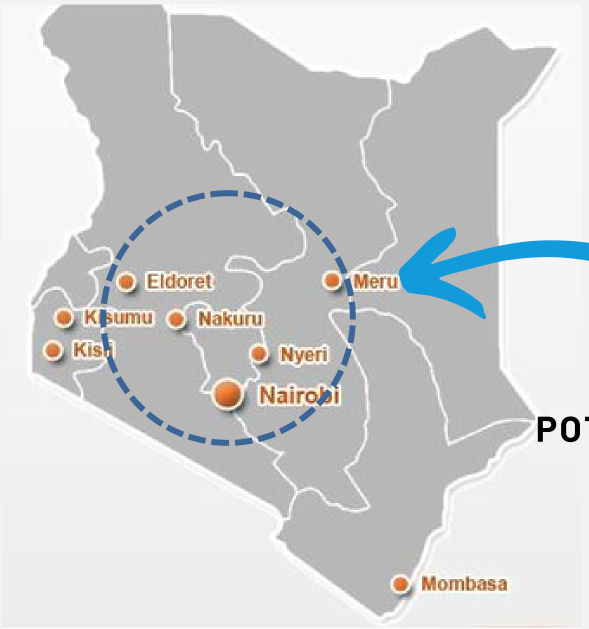
Tonnes of SugarCane Consumed - **200,000/yr**
Electricty Requires - 200,000 * 100 kWh/ton
i.e. **20,000 MWh / yr**
Our Electricity Price - **0.05 USD per kWh**
Therefore Our Revenue (From SugarCane Industries will be) - **1,000,000 USD / yr**
Our Investment - **6 million USD**
ROI = **6 years.**

OUTCASTS

FINANCE MODEL - ELECTRIC STOVE

FINANCIAL FACTORS

Average Cost of an Electric Stove - **5,000 to 20,000 KSH.**
i.e. 50 to 200 USD.



POTENTIAL ZONES

Target Population
15.95 million **(3,700,000 families)**
Urban Kenya

IMPLEMENTATION

Electric Stove uses - 1,500 watt
i.e. Cooking meal on stove for one hour will require **1.5 kilowatt-hours (kWh)** of electricity.
Urban Population Consumption - 150 kWh of electricity per month

SUBSIDIES

- Electricity consumption for cooking using electric stove is recorded. And the GOK(Govt of Kenya) will give the first 40 units free of cost.
- Example if 100 units are consumed using electric stove then the family will cost for only 60 units.

ROI CALCULATIONS

Based on Kenya' Previous Response on Electric Cooking Appliances.
A **PPP** setup is preferred.

Return on Investment can be expected in around 8 - 9 years. Keeping the subsidies given in mind.

IMPLEMENTATION ROADMAP: SUPPLY CHAIN ANALYSIS

OUTCASTS

SITE SELECTION

- Near **Sugarcane**, **Coffee industries**, we are going to use the industrial digestor for Biogas Plant.
- In the rural households we have planned to use the **fixed size dome one**.
- In the urban households, the people will be given subsidies for using the **Electric Stove**.

TECHNICAL AWARENESS

- Kenya Bureau of Standards (KEBS)
- Kenya National Cleaner Production Centre (KNCPC)
- Clean Cooking Alliance (CCA)

GENERATION

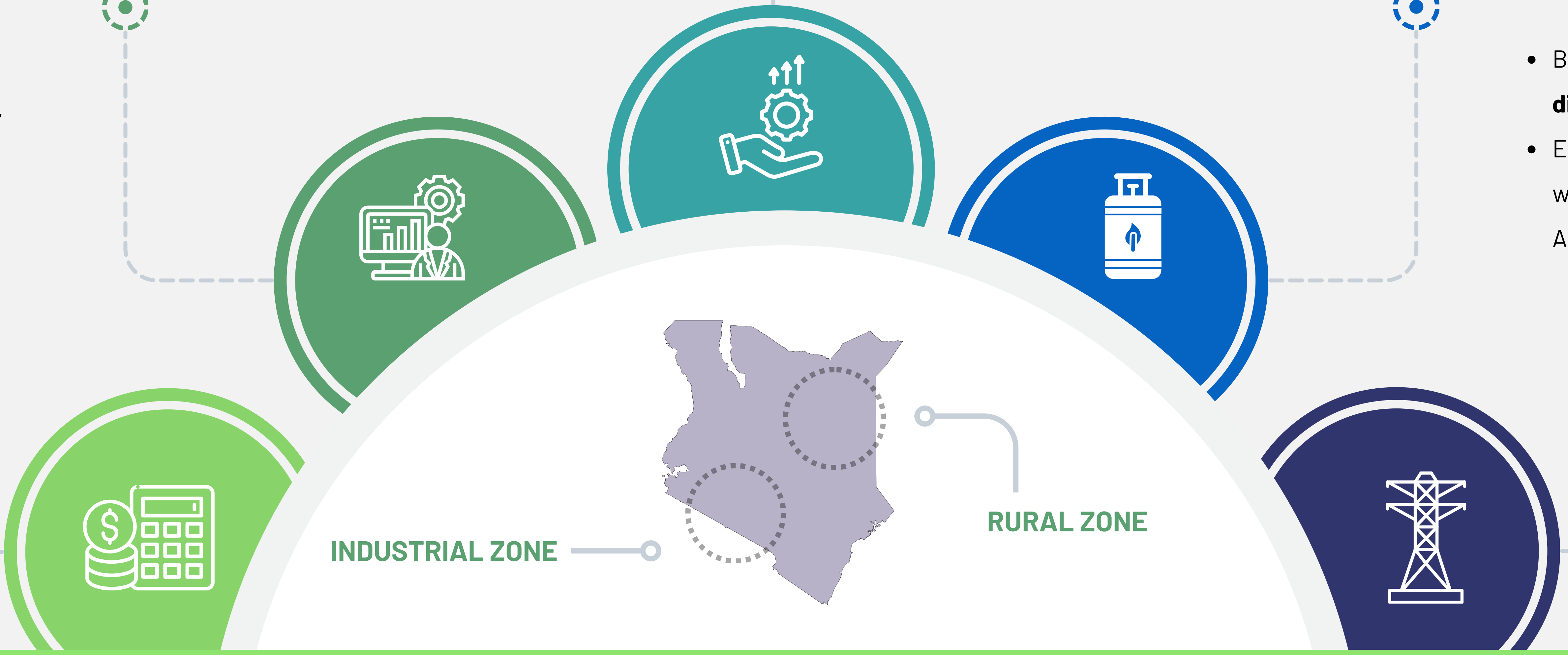
- Biogas plants - **Government + KenGen**.
- Electric Stove -
- Private - Nairobi Home Appliances Limited, Electrical & General Appliances Ltd, etc.

FINANCING

- African Biogas Partnership Programme (ABPP).
- PREO (Powering Renewable Energy Opportunities)
- Kenya Community Development Foundation (KCDF)

DISTRIBUTION

- BIOGAS - Government will handle the **distribution among rural** population.
- ELECTRIC STOVE : PPPs, REREC, etc. will distribute among urban households. And Govt. will provide subsidies .



SOLAR PLANTS - PRELIMINARY

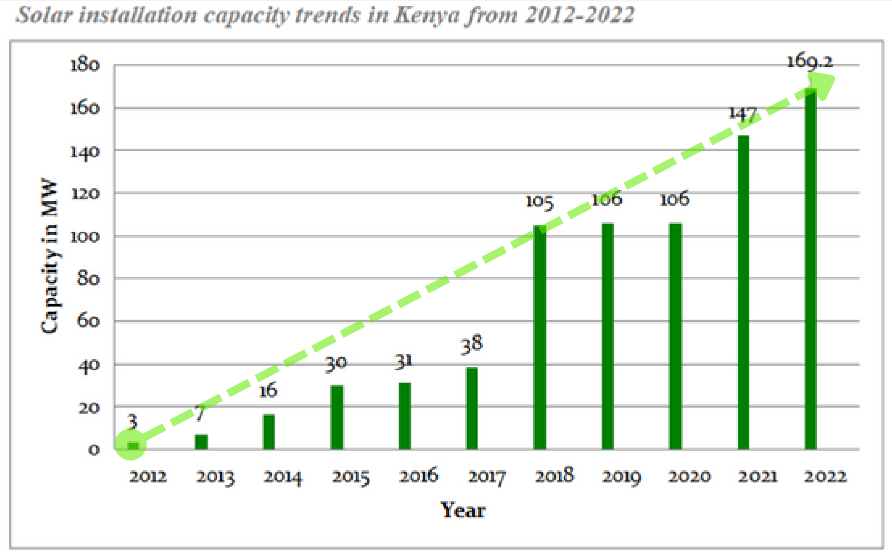
OUTCASTS

CURRENT SCENARIO

- Solar energy is almost ubiquitous across Kenya, both at utility scale and through **solar home systems (SHS)**.
- SHS have provided an **affordable route to energy access** for millions across Kenya – especially amongst rural communities – as it allows them to bypass central grid connection, which can often be prohibitively expensive.
- Approximately **200,000 rural homes in Kenya have SHS** and the country sells between **25,000 and 30,000 photovoltaic** modules each year, making it the second most dynamic commercial solar marketplace in the world after India.

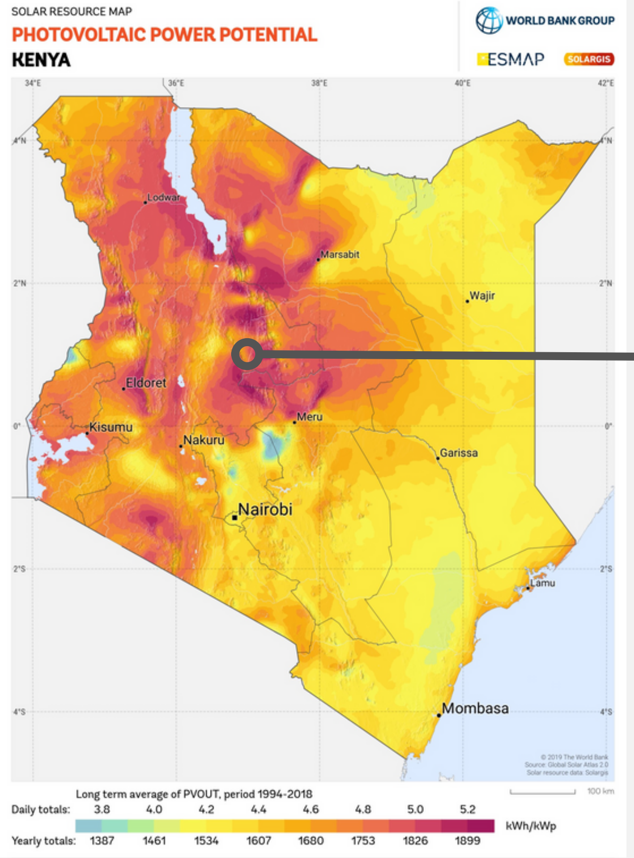
GOVERMENT EFFORTS?

- **Reinstated VAT exemption on solar and wind energy equipment**: This measure makes it more affordable for Kenyans to purchase solar panels and other solar equipment.
- **Launched the Net Metering Policy**: This policy allows homeowners and businesses to sell excess solar-generated electricity back to the grid, which can help to offset their electricity bills.
- **Established the Solar Power Purchase Agreement (PPA) Program**: This program provides financial incentives to developers to build large-scale solar power plants in Kenya.
- **Launched the Kenya Off-Grid Solar Access Project (KOSAP)**: This project aims to provide access to solar energy to 1 million Kenyans living in off-grid communities.



Solar installation capacity trends in Kenya | Sources:AFSIA; IRENA; KENPRO, 2023

The Solar Market is similar to that of Geothermal, but it requires some technical advancments to unlock full potentials.



POTENTIAL ZONES

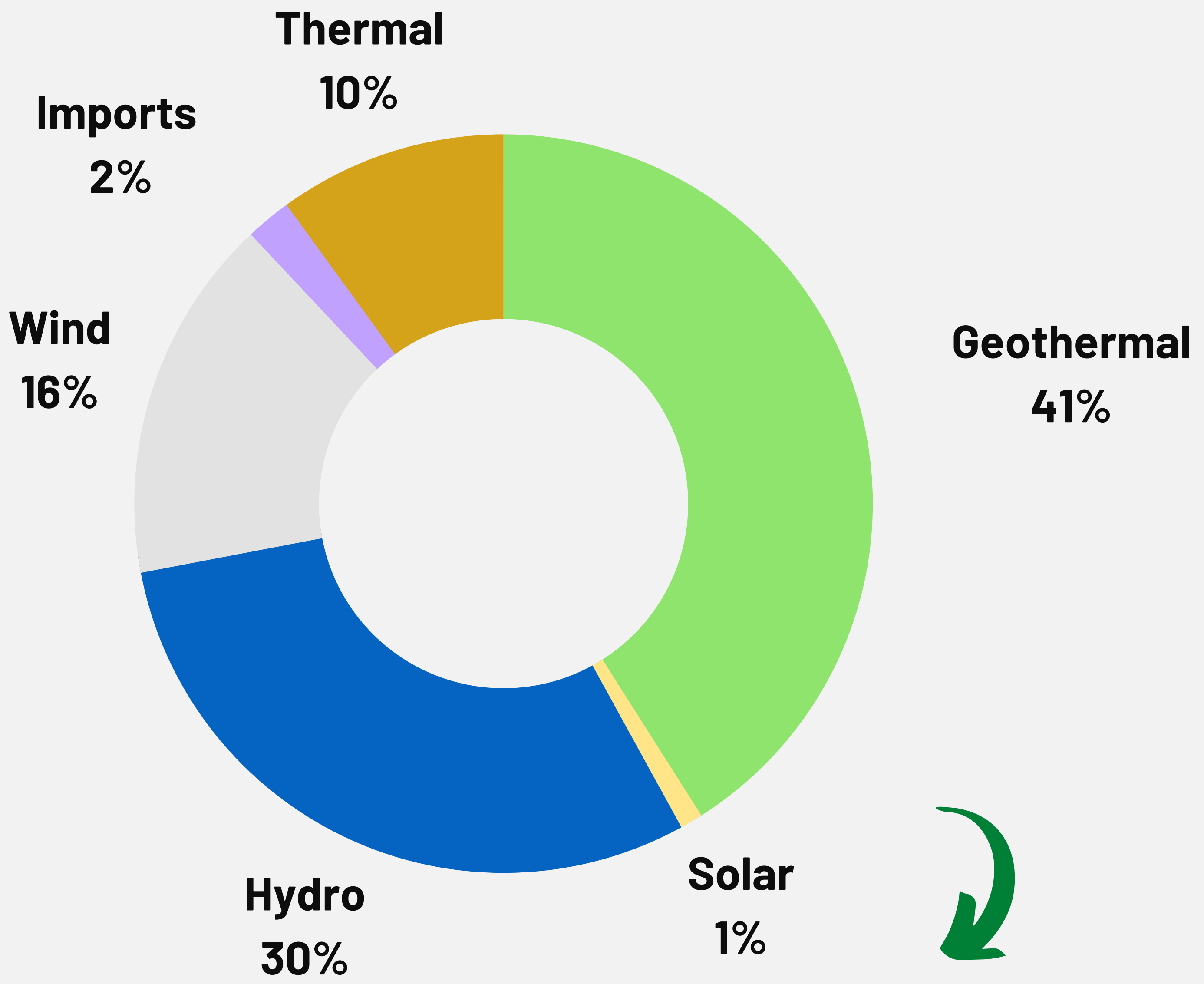
SOLAR PLANTS - PRELIMINARY

OUTCASTS

CURRENT PROJECTS

PROJECT NAME	CAPACITY (MW)	LOCATION	STATUS
GARISSA SOLAR PROJECT	55 MW	SULMAC Vil.	Running
MALINDI SOLAR PLANT	52 MW	SULMAC Vil.	Running
ALTEN KEESSES (1)	52 MW	SULMAC Vil.	Running
KOPERE SOLAR PROJECT	50 MW	SULMAC Vil.	Running
Eldosol Solar Plant	48 MW	EBURRU	Running
RADIANT	50 MW	SULMAC Vil.	Running
RUMURUTI SOLAR PROJECT	40 MW	NAKURU	To be Est.
MAKINDU SOLAR PLANT	33 MW	Makindu	Running
NAKURU (MIGITIYO)	40 MW	NAKURU	To be Est.

SHARE IN RENEWABLE MIX



Kenya has seen significant growth in solar energy adoption, driven by government incentives, increased investment, and declining solar technology costs. This expansion enhances energy access and sustainability.

HOW WE CAN RISE THE SHARE OF SOLAR?

OUTCASTS

OFF GRID SOLAR PLANT

URBAN

ROOF TOP

- Install solar panels on **rooftops of buildings** to generate electricity for the building.
- Kenya has a high solar potential, with an average **of 5.5 kWh/m^2/day of solar radiation.**
- This means that rooftop solar panels can generate a significant amount of electricity, **even in urban areas.**

SOLAR TREE

- Install solar trees in parks and other **public spaces** to generate electricity and set accomdation,
- Solar trees can provide electricity for **urban communities** that are **not connected** to the grid.
- Solar trees can also provide shade and seating, making them a valuable community asset.

RURAL

SOLAR FARM

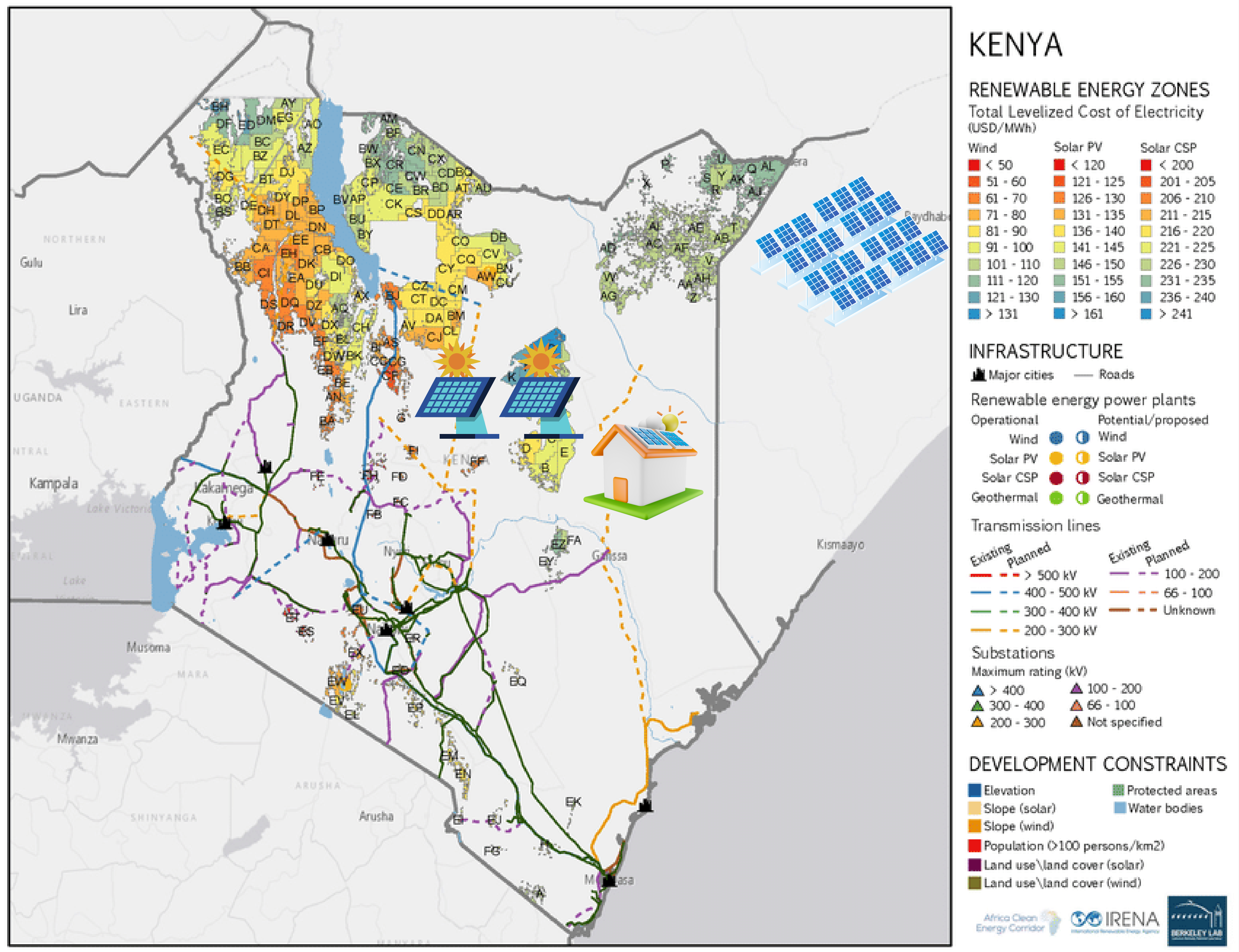
- Establish solar farms on **unused land in rural areas** to generate electricity for the village.
- Kenya has a lot of unused land in urban areas, which is **ideal for solar farms.**
- Solar farms can generate a large amount of electricity, which can **help to reduce the country's reliance on fossil fuels.**

COMMUNITY PARK

- Generate electricity for the park and provide a space for people to **gather and enjoy the outdoors.**
- These Community park may establish a long lived **bonding in Kenya towards Solar Energy.**
- Community parks can also help to **promote social cohesion and economic development** in rural communities.

OUTCASTS

OFF GRID SOLAR : MAP EXPLORATION



URBAN POPULATION :

POPULATION DENSITY = HIGH

SOLAR PARKS DENSITY = LOW

SOLAR PARK ENERGY CAPACITY AND GENERATION = **HIGHER**

RURAL POPULATION

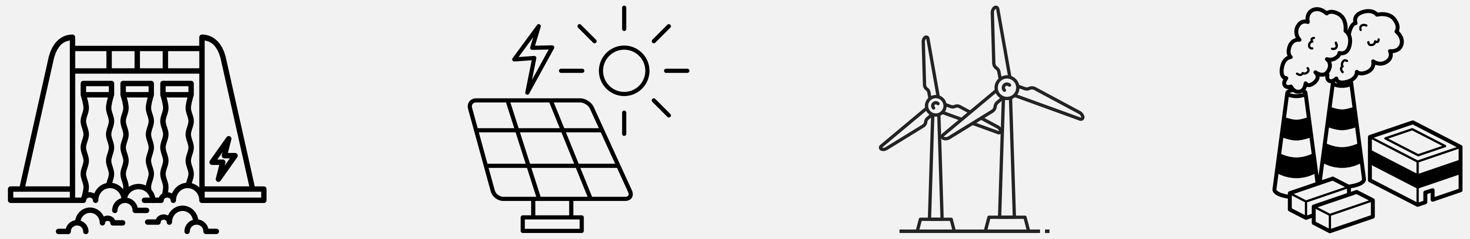
POPULATION DENSITY = LOW

SOLAR PARKS DENSITY = HIGH

SOLAR PARK ENERGY CAPACITY AND GENERATION = **MODERATE -- LOW**

WHY SOLAR IN KENYA?

Kenya **enjoys abundant sunlight throughout the year**, making solar power a consistently reliable and **efficient energy source**. Solar installations are relatively easy to set up and maintain, making them cost-effective. Additionally, solar energy is environmentally friendly, **helping reduce greenhouse gas emissions** and combat climate change..



FACTOR	HYDRO	SOLAR	WIND	THERMAL
AVAILABILITY	Reliable, but dependent on rainfall	Intermittent, but abundant	Intermittent, but abundant	Reliable, but not clean
COST	High upfront cost, low operating cost	Medium upfront cost, low operating cost	Medium upfront cost, low operating cost	Low upfront cost, high operating cost
EMISSIONS	Low emissions	Zero emissions	Low emissions	High emissions
LAND USE	Medium land use	High land use	Medium land use	Low land use
ENVIRONMENTAL IMPACT	May disrupt fish migration and flood downstream communities	It can have a visual impact on the landscape	May disrupt routes of birds and bats	Produces air pollution and greenhouse gas emissions
STATS FOR KENYA	**6,000 MW** of potential capacity	**5.5 kWh/m2** of average daily solar radiation	**10,000 MW** of potential capacity	37% of Kenya's electricity generation mix

It also **reduces dependence on fossil fuels**, contributing to energy security. In contrast, thermal power can be costly and polluting, wind power can be inconsistent, and **hydro projects can disrupt ecosystems** and water resources. Solar energy offers a sustainable, clean, and practical solution for Kenya's energy needs

SETTING UP SOLAR FARMS

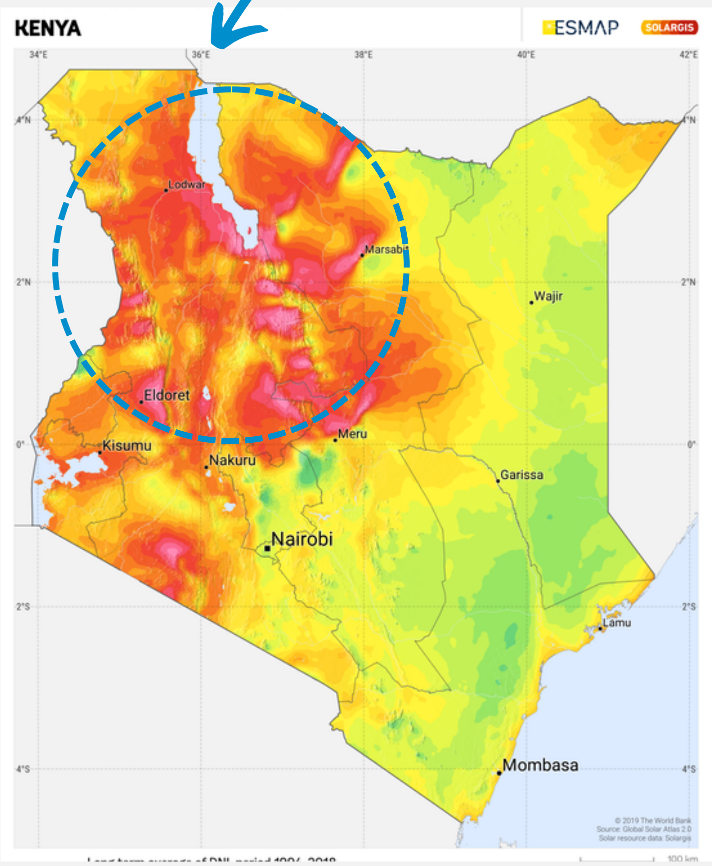
OUTCASTS

FINANCE MODEL - SOLAR FARMS

FINANCIAL FACTORS

Population - **1.2 million**
Current Average per person Average Electricity - **150 kWh/yr**
Target Increased Consumption - **400 kWh/yr**

POTENTIAL ZONES



IMPLEMENTATION

- Solar panels: **$100 million**
- Installation: **$50 million**
- Other costs (land acquisition, engineering, legal fees): **$50 million**
- Total capital costs: **$200 million**

Solar Farm electricity production - 300 - 400 MW

Region -- Estimated electricity production (**MW**) |

Sunny region -- 500 MW
Moderately sunny region -- 400 MW
Cloudy region -- 250 MW

Here the finances is shown only for the TURKANA COUNTY of Kenya.
The total Energy and Revenue can be predicted further.

ROI CALCULATIONS

- Here the investment would be based on the **solar irradiance** i.e. the **heat regime** will be preferred.
- And the investment done here is to setup an electricity source not to gain profit.

SETTING UP ROOFTOP - SOLAR

OUTCASTS

FINANCE MODEL - ROOFTOP SOLAR

FINANCIAL FACTORS

Target Population - **Urban Population**

POTENTIAL ZONES

IMPLEMENTATION

The cost of rooftop solar in Nairobi, Kenya, is typically between **$0.70 and $1.60 per watt.**

Average Household Consumption in Nairobi, Kenya - **250 kWh per year**

The rooftop solar can help the families to save the electricity bill by approx upto **80 %.**

ROI CALCULATIONS

- A 5 kW system, which is enough to power a small home, would cost between **$3,500 and $8,000**.
- A 10 kW system, which is enough to power a medium-sized home, would cost between **$7,000 and $16,000.**

The Families will get the payback of Solar Rooftop by **6 years**. But this time will be reduced as the government will be providing with **easy loans and loose in taxes** for this rooftop solar.

Here the Target Zones are Considered only the rich cities of Kenya.
The total Energy and Revenue can be predicted further.

WHY INVESTING GEOTHERMAL MORE?

OUTCASTS

- **Renewable and Versatile:** Geothermal energy is a renewable resource found in the Earth's crust, offering electricity production, greenhouse heating, and tourist attractions.

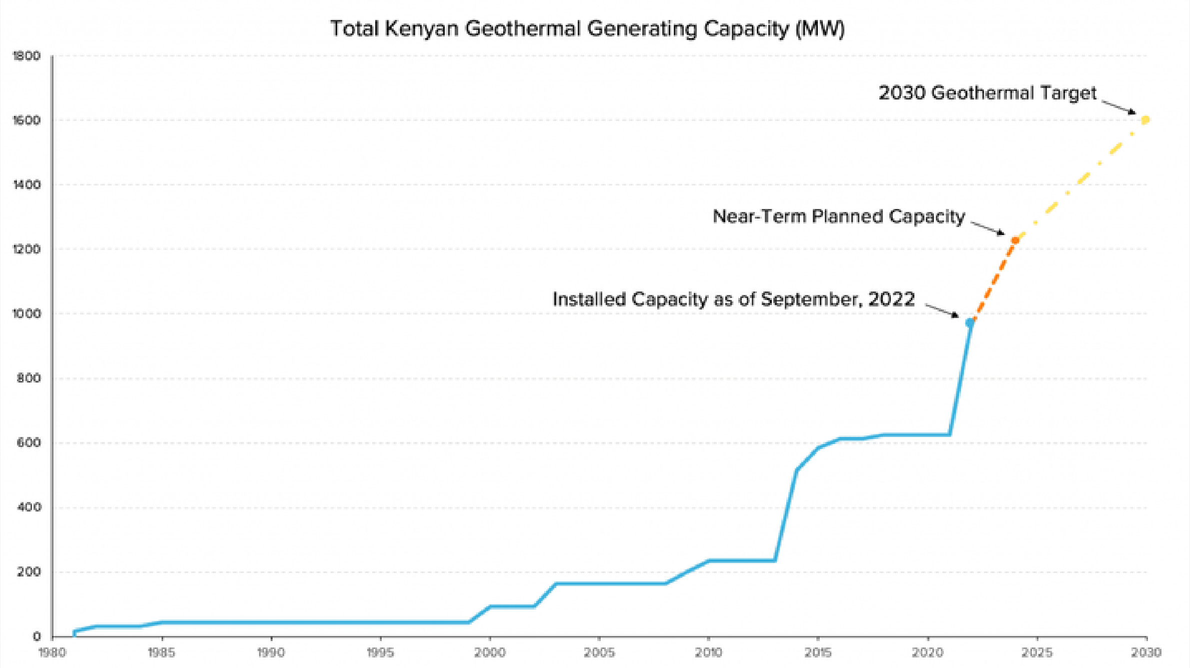
- **Reliability Over Rain-Dependent Hydropower**: Kenya's heavy reliance on hydropower, dependent on rainfall, has led to unreliable electricity supply, as seen in the challenging year 2000.

- **Vast Geothermal Resources in Rift Valley:** Kenya's Rift Valley hosts extensive geothermal resources, providing a sustainable, cost-effective, and eco-friendly solution to the country's growing energy demands.

- **Diverse Geothermal Power Technologies:** Geothermal power production encompasses technologies like dry steam, flash steam, binary cycle systems, and hot dry rock, enhanced geothermal systems ensuring stable energy generation independent of daily or seasonal weather patterns.

	1995		2005		2015	
Energy sources	GWh		GWh		GWh	
Oil	416	10.2%	1645	28.3%	1206	12.4%
Biofuels	122	3.0%	131	2.3%	122	1.3%
Hydro	3163	77.3%	3026	52.0%	3787	39.1%
Geothermal	390	9.5%	1003	17.2%	4479	46.2%
Solar PV			13	0.2%	37	0.4%
Wind					57	0.6%
Total	4091	100%	5818	100%	9688	100%

Source: International Energy Agency (2020).

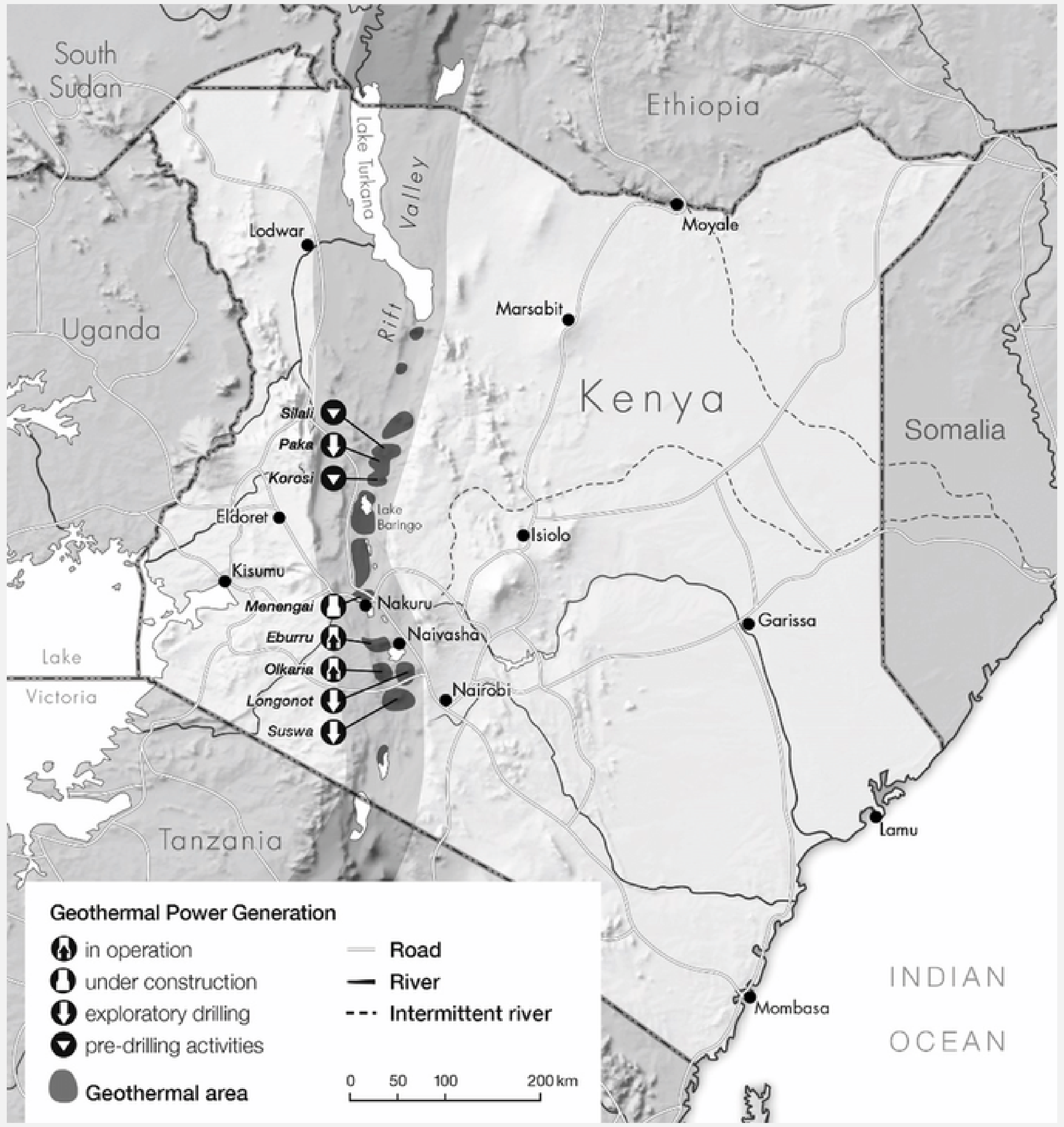


The main reason, we are trying extract each case of Geothermal is that it greatly promises its **future growth**.

GEOTHERMAL PROJECTS

OUTCASTS

PROJECT NAME	CAPACITY (MW)	LOCATION	MAIN PURPOSE	STATUS
OLKARIA I	268.3 MW	SULMAC Vil.	Electricity Generation	Running
OLKARIA II	105 MW	SULMAC Vil.	Electricity Generation	Running
OLKARIA IV	140 MW	SULMAC Vil.	Electricity Generation	Running
OLKARIA V	158 MW	SULMAC Vil.	Electricity Generation	Running
ONGOING GEOTHERMAL PROJECTS	75 MW	EBURRU	Electricity Generation	Running
OLKARIA III	139 MW	SULMAC Vil.	Electricity Generation	Running
MENEGAI	165 MW	NAKURU	Electricity Generation	To be Est.
LONGONOT	140 MW	NAKURU	Electricity Generation	To be Est.



This clearly shows that Kenya is lacking extinsive use of geothermal's vast application other than electricity generation.

Ref: International Energy Agency: IEA

VAST APPLICATIONS OF GEOTHERMAL

OUTCASTS

Agriculture Drying

Geothermal heat can dry crops quickly and efficiently, reducing spoilage and preserving quality, and produce valuable biochar soil amendment.

Aquaculture Heating

Geothermal heat can heat aquaculture ponds, extending the growing season, increasing fish production, and reducing the environmental impact by reducing the need for fossil fuels.

Space Heating

Geothermal heat pumps or direct geothermal systems heat homes and buildings more efficiently and environmentally friendly than gas or oil furnaces.

Community Cooking

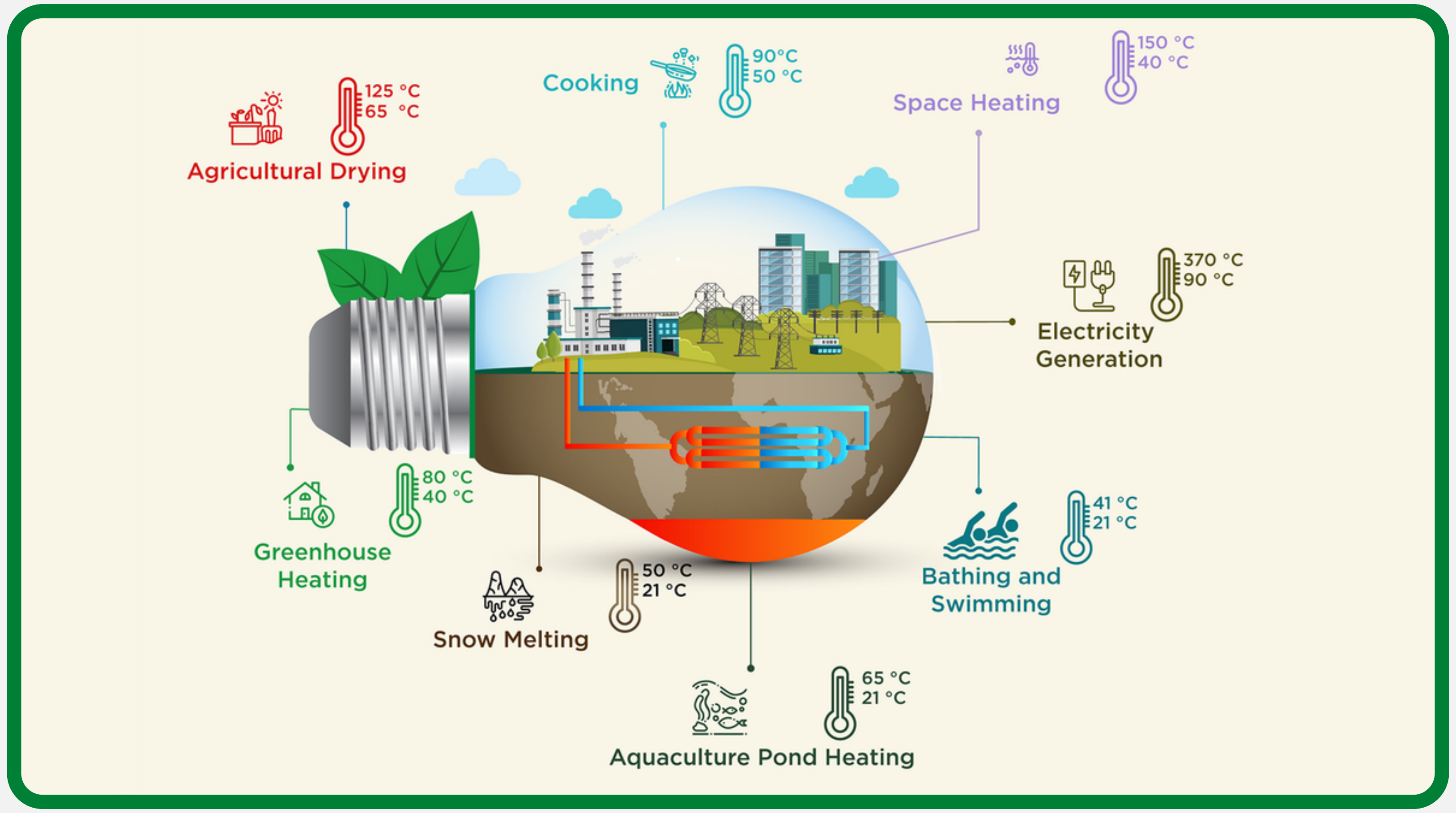
Geothermal heat can cook food in community kitchens and food banks more efficiently and environmentally friendly than gas or electric stoves.

Food Processing

Geothermal heat can dry crops quickly and efficiently, reducing spoilage and preserving quality, and produce valuable biochar soil amendment.

Greenhouse Heating

Geothermal heat can heat greenhouses year-round, extending the growing season and allowing for a wider variety of crops, while reducing greenhouse gas emissions.



Tourist Attraction

Geothermal hot springs and geysers can be developed into spas, resorts, and theme parks, boosting local economies and creating jobs.

Cooling

Geothermal heat pumps cool buildings more efficiently and environmentally friendly than traditional air conditioning.

SOLUTION

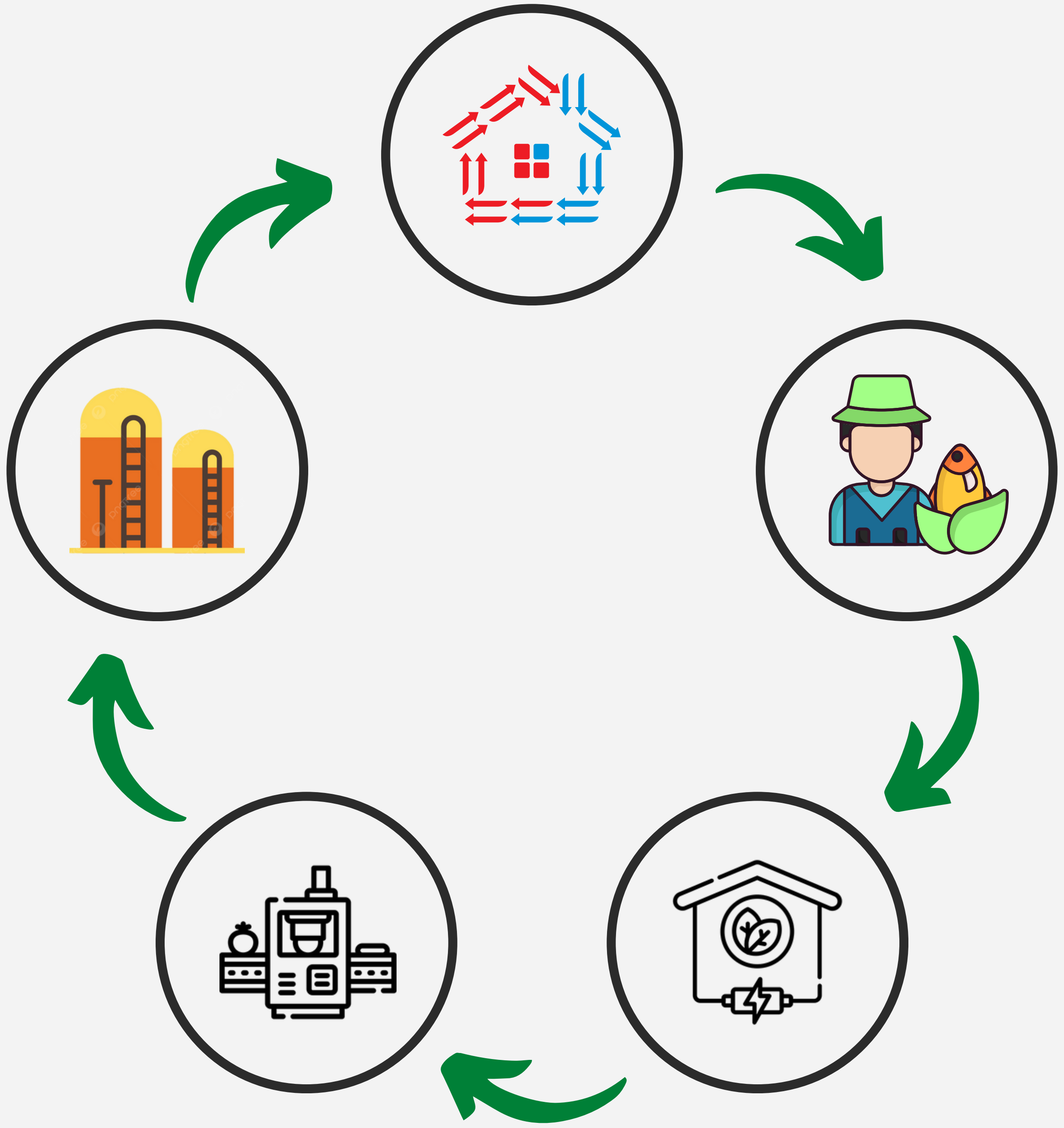
KENYA

VAST APPLICATIONS ADVANTAGES & DISADVANTGES

OUTCASTS

OPPORTUNITIES

- Reducing reliance on fossil fuels and promoting a cleaner energy mix.
- Job creation through the development and maintenance of geothermal infrastructure.
- Enhanced energy security and reliability.
- Attracting investment, both domestic and foreign, in the geothermal sector.
- Economic diversification and growth, especially in rural areas.



CHALLENGES

- High upfront costs for geothermal exploration and development.
- Environmental and land use concerns, as geothermal projects can impact local ecosystems.
- Technical challenges in drilling and maintaining geothermal wells.
- The need for skilled labor and specialized knowledge in geothermal technology.
- Financing and investment challenges, as geothermal projects may require significant capital.

FINANCE MODEL - EXPANSION

FINANCE OF EXPANSION

For Expanding a Geothermal Powerplant Capacity- **50 MW**

- Drilling new wells: **USD 10 million**
- Building new turbines, new transmission lines, etc.(civil work): **USD 50 million**
- **Insurance and taxes**: **USD 0.5 million**
- Total project cost: **USD 60.5 million**

ROI CALCULATIONS

- Assume if we expand any geothermal plant production by just 10 %. The **Payback can be recieved in just 3 - 4 years**. (Which is the best ROI among all the approaches taken so far).
- The Investment done on the Packages will help to **utilise the Geothermal Plant** to a better Phase and help in **community beniefits.**

IMPLEMENTATION

PACKAGE 1

Agriculture Drying

Cost: **$1,000-$10,000** per acre
Energy capacity: **1-10 MW**

Food Processing

Cost: **$10,000-$100,000** per facility
Energy capacity: **10-100 MW**

Greenhouse Heating

Cost: **$10-$50** per square foot
Energy capacity: **0.1-1 MW** per acre

Aquaculture Heating

Cost: **$1,000-$10,000** per acre
Energy capacity: **1-10 MW**

Space Heating

Cost: **$5-$20** per square foot
Energy capacity: **0.05-0.2 MW** per home

Resident Cooling

Cost: **$10-$50** per square foot
Energy capacity: **0.1-1 MW** per acre

PACKAGE 2

Tourist Attraction

Cost: **$10-$50** per square foot
Energy capacity: **0.1-1 MW** per acre

Community Cooking

Cost: **$10-$50** per square foot
Energy capacity: **0.1-1 MW** per acre

SETTING UP GEOTHERMAL PLANTS

OUTCASTS

FINANCE MODEL - NEW SETUP

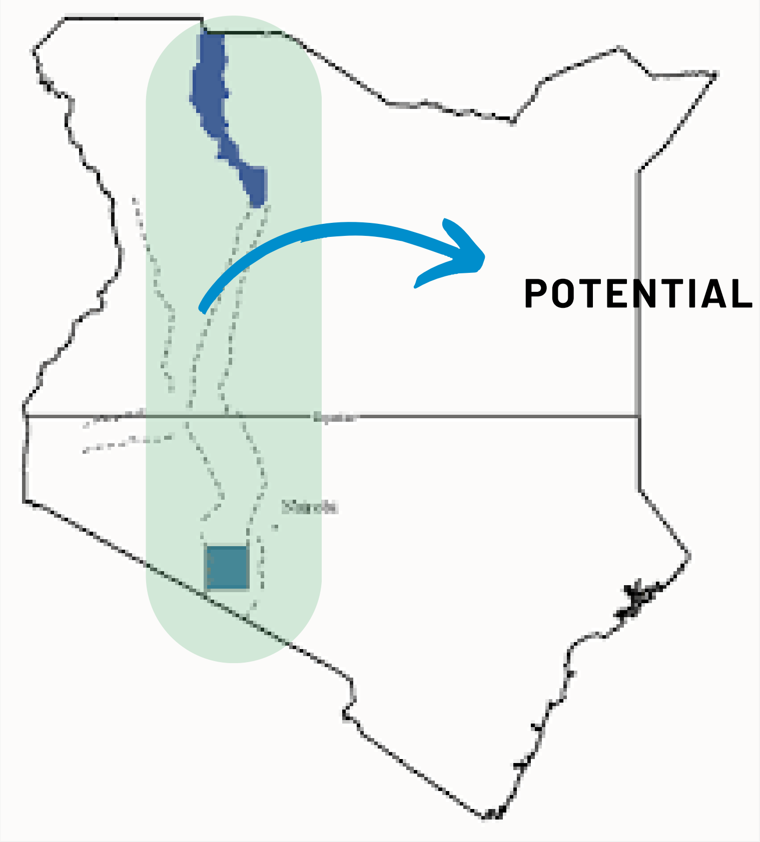
POTENTIAL ZONES

MENEGAI NORTH - POTENTIAL OF 1MW

LAKE MAGADI - POTENTIAL OF 1 MW

ARUS - POTENTIAL OF 1 MW

BARINGO - POTENTIAL OF 0.5 MW



POTENTIAL ZONES

FINANCE OF SETUP

Lets consider for **Lake Magadi**, Kenya

- Drilling new wells: **USD 150 million**
- Building a new power plant: **USD 100 million**
- Connecting the plant to the grid: **USD 75 million**
- Other costs (land acquisition, EIA, community engagement, regulatory compliance, etc.): **USD 75 million**

TOTAL PROJECT COST: **USD 400 MILLION**

Here the finances is only shown to setup a plant in Lake Magadi of Kenya. The total Energy and Revenue can be predicted further.

ROI STATEMENT

The LCOE (Levelized Cost of Energy) of our 50MW Setup - **0.07 USD/kWh**

Setup Time Required - **4 - 5 years.**

A **Large Sum of Available Capital** will be invested in the Geothermal Plant setup and Further Advancements.
As it is the **main hub of Energy for Kenya**.

SUPPLY CHAIN - GEOTHERMAL

OUTCASTS

	Exploration			Exploitation		
Phases	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
	Recognition	Exploration	Exploratory drilling	Feasibility	Field development	Construction
Generic activities	Licenses acquisition	Geology detailed	Drilling and evaluation of exploration wells	Financing analysis	Well drilling	Construction of the plant
	Regional surface geological exploration	Geochemistry	Parameter evaluation	Conceptual design	Exploitation designs	Drilling and evaluation of wells
	Geochemical exploration	Geophysical studies	Static reservoir characterization	Reservoir evaluation	Plant design	Construction of vapor ducts and surface equipment
		Location of sites to drill	Delimitation of the exploration area	Feasibility report	Design of steam transport and equipment	Admission tests and turbine treading
Main objectives	Surface recognition	Confirmation of geothermal conditions	Geothermal reservoir confirmation	Techno-economic feasibility	Techno-economic infrastructure	Commercial operation start-up

CRUCIAL OBJECTIVES

01 EXPLORATION
- Geophysical Studies
- Location of Drill Sites

02 FEASIBLITY
- Financing Analysis
- Techno-economic Feasiblity

03 FIELD DEVELOPEMENT
- Design of steam transport and equipment.
- Well Drilling

04 CONSTRUCTION
- Construction of the Plant at sites.
- Transmisson among neighboring areas

WHICH COMPANIES TO APPRAOCH?

Leading in Solar

Global frontier in solar technology and expertise, providing solutions worldwide.

First Solar

JinKO Solar
Building Your Trust in Solar

LONGi Solar

Leading in Geothermal

These companies excels in geothermal energy on a global scale.

ORMAT

BASELOAD CAPITAL

CALPINE

Leading in BioGas

These companies have proved why they are prominent global player in the biogas industry.

EnviTec Biogas

WELTEC BIOPOWER

Verbio

Notable Companies

These are internationally recognized companies with diverse operations.

Trinasolar

CanadianSolar

CAPITAL ENERCAP

KENYA
PHASE - 02 - PLAN

OUTCASTS

2025 - 2027 | **2028 - 2031** | 2032 - 2035

02

EXPANSION FROM PHASE 1

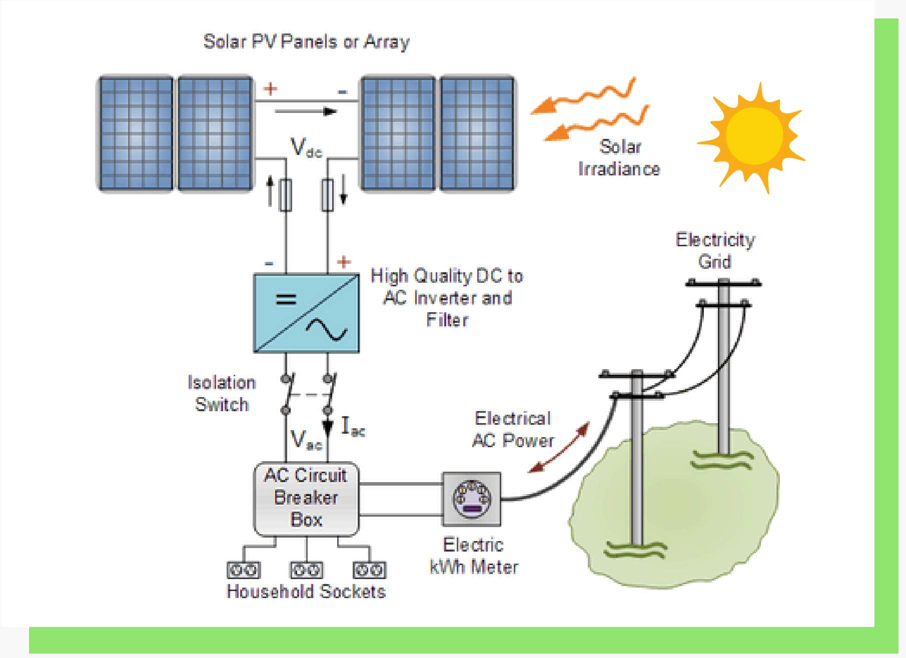
01

03

FLOATOVOLTAICS

AGROVOLTAICS

CONNECTING OFF GRID TO CENTRAL GRID



EXPANDING NEW TECHNOLOGIES - SOLAR

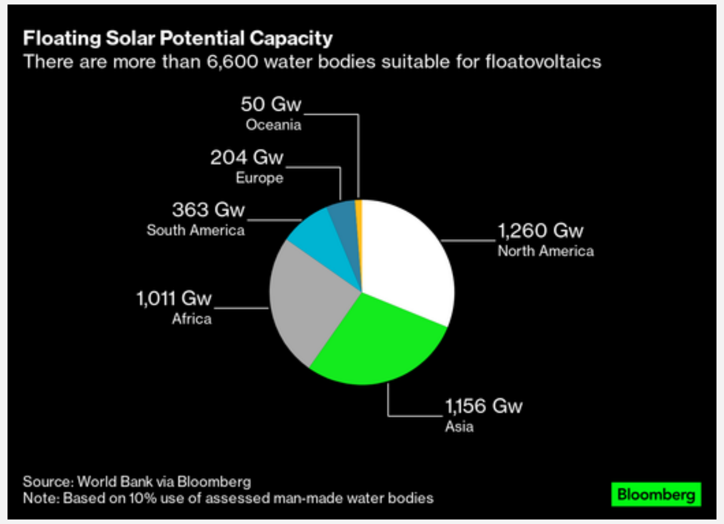
OUTCASTS

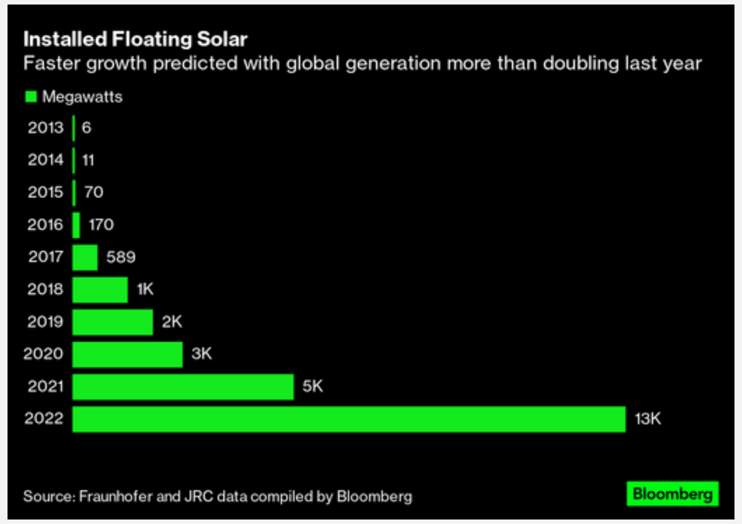
FLOATOVOLTAICS

- Floatovoltaics have **low maintenance and management costs** and remove the requirement for costly land areas. They can also breathe life into sites that have fallen into neglect, such as former gravel and sand pits.
- Floatovoltaics are floating solar plants that can help Kenya's push towards renewable energy.
- They can be installed in existing hydropower reservoirs to:
  - Provide solar electricity **during dry periods**.
  - **Reduce evaporation** losses.

WHY IN KENYA?

- Kenya has significant potential for floatovoltaics, given its **abundant water** resources and solar radiation. The country has an estimated **6,000 MW** of hydropower potential, and many of its hydropower reservoirs could be used to install floatovoltaic plants.
- Floatovoltaics can also help to **improve the efficiency of hydropower plants**. By reducing evaporation from reservoirs, floatovoltaics can **increase the amount of water available for hydropower generation**. This can be especially beneficial **during dry periods** when hydropower generation is typically lower.





This innovative approach **maximizes land use efficiency**, generates renewable energy, and conserves water resources, making it a **sustainable solution** to meet the country's growing energy needs while **addressing land scarcity**.

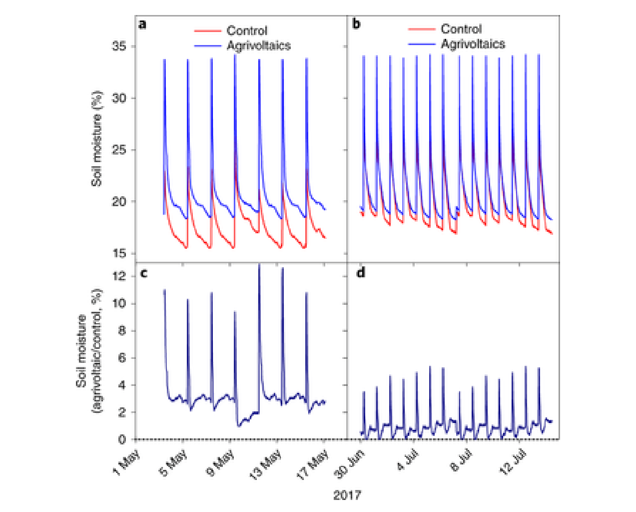
EXPANDING NEW TECHNOLOGIES - SOLAR

OUTCASTS

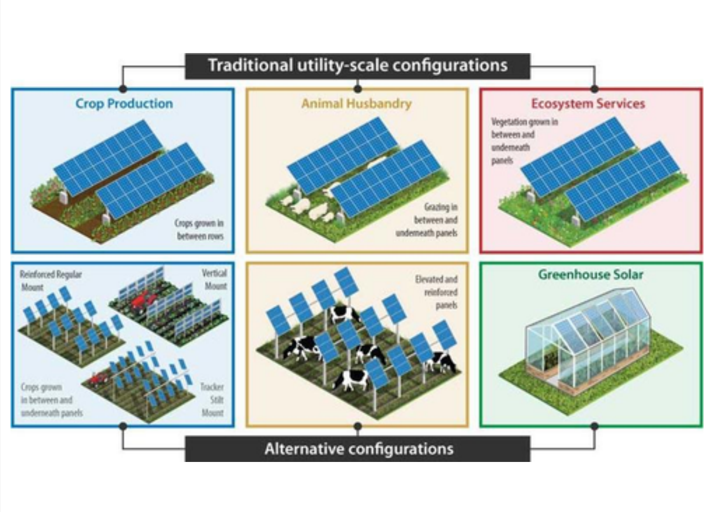
AGROVOLTAICS

- Agrivoltaics, the **technique harvests solar energy twice**: where panels have traditionally been used to **harness the sun's rays** to generate energy, they are also utilised to provide shade for growing crops, **helping to retain moisture in the soil** and **boosting growth**.

- For example, cabbages grown under the 180, 345-watt solar panels have **been a third bigger, and healthier**, than those grown in control plots with the **same amount of fertiliser and water.**



Ref: www.researchgate.net



Ref: www.waaree.com

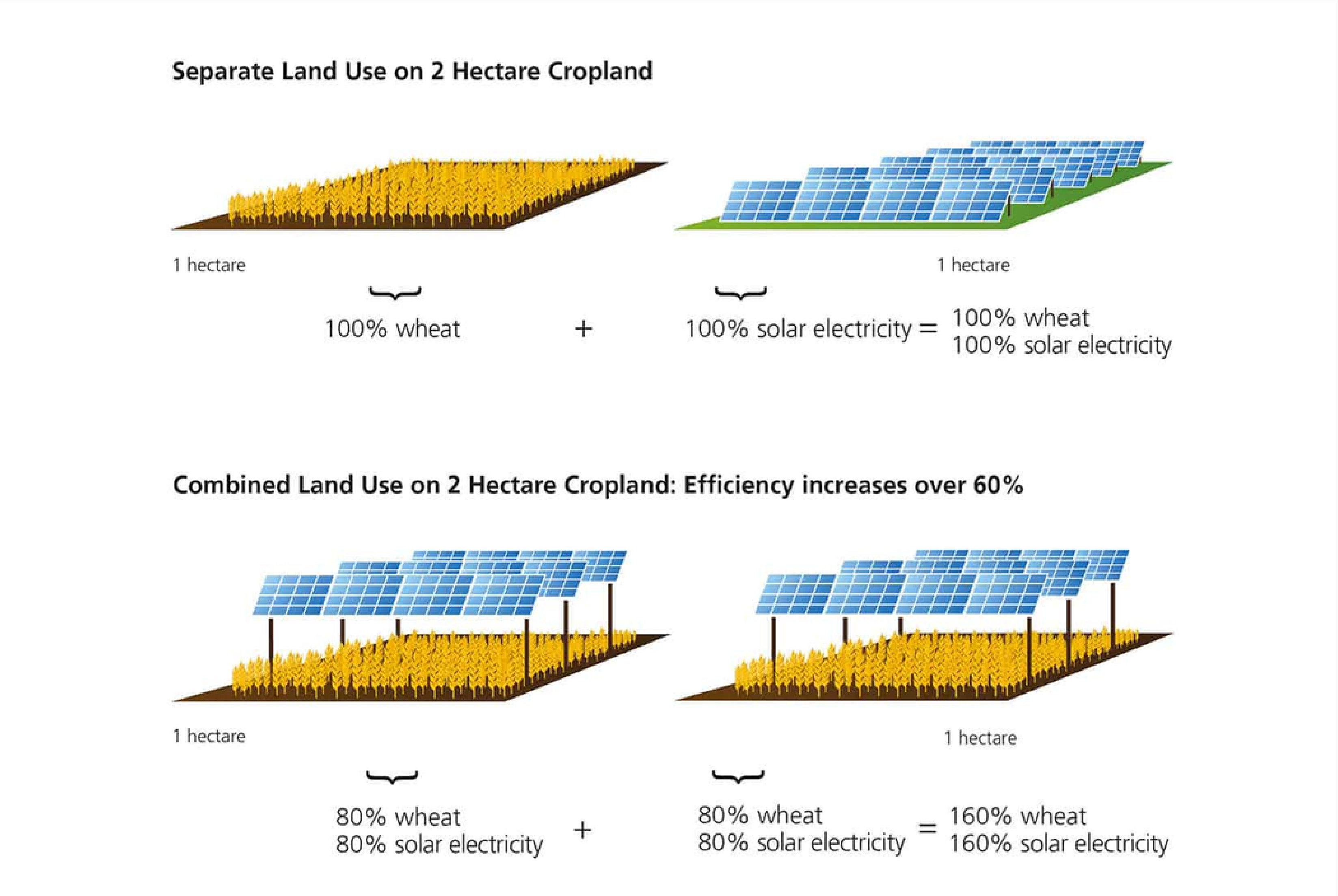
WHY IN KENYA?

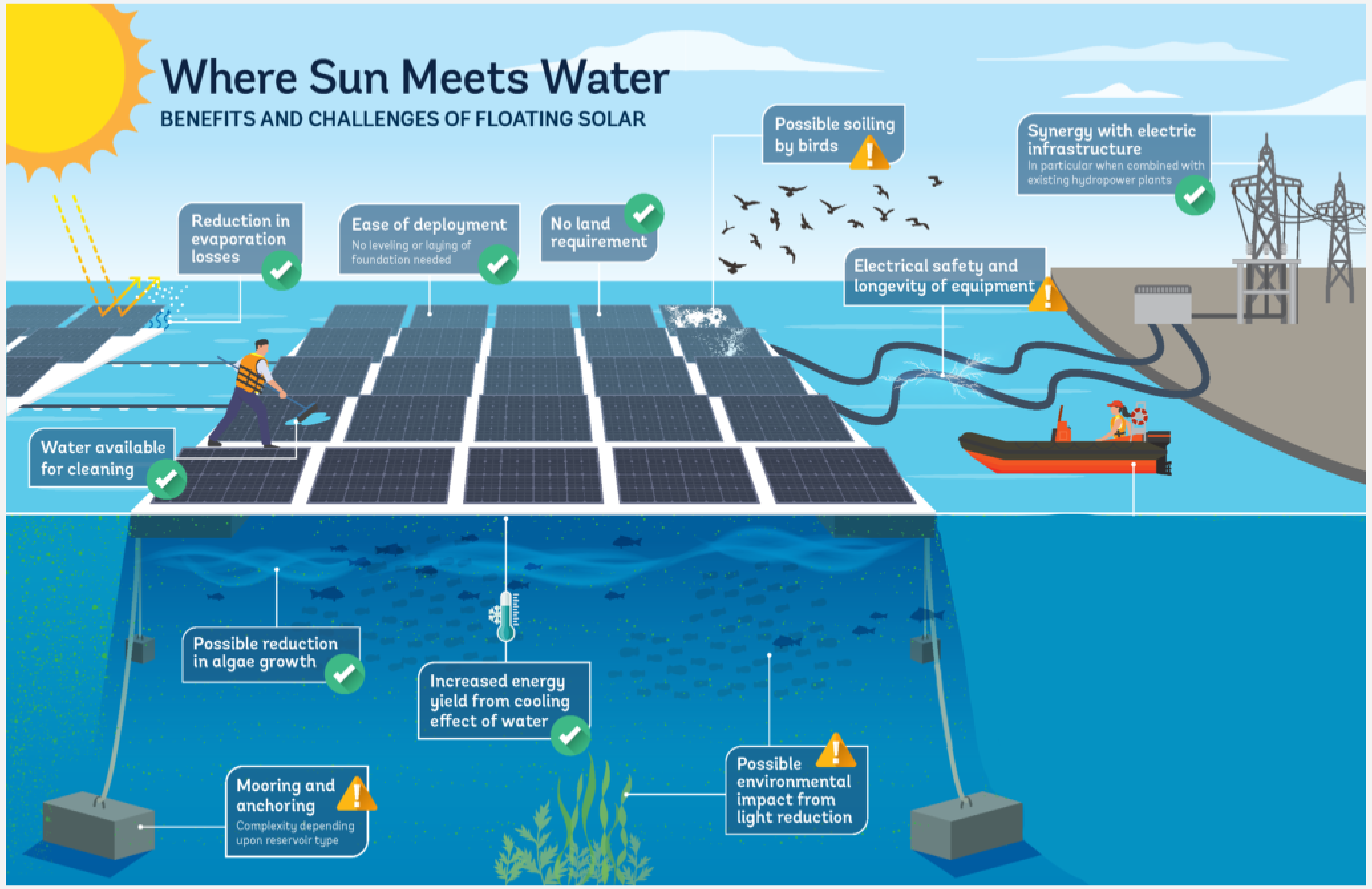
- **Increased crop yields:** Agrovoltaics can increase crop yields by **up to 60%**. This is because the solar panels provide partial shading to the crops, which can help to reduce heat stress and water evaporation.
- **Reduced water use:** Agrovoltaics can also help to reduce water use by **up to 50%**. They help to reduce soil evaporation and improve soil moisture retention.
- **Improved soil quality:** Agrovoltaics can also help to improve soil quality by adding organic matter to the soil and **reducing soil erosion**.
- **Additional income for farmers**: Agrovoltaics can provide farmers with an additional source of income from the **sale of electricity**.

- **Agrovoltaics in Kenya is rapidly expanding**, blending solar power generation with agricultural practices.
- This dual land use approach **maximizes land productivity and renewable energy generation**, promoting sustainability.

BENEFITS OF THESE TECHNOLOGIES?

OUTCASTS





- Benefits include **increased crop yield, reduced evaporation, and additional income for farmers.** This approach promotes sustainable energy generation while addressing **food security** and **water conservation.**

- It offers advantages **such as reduced water evaporation**, enhanced **solar panel efficiency**, and **water quality maintenance**. This innovative approach contributes to renewable energy generation and **environmental sustainability**.

EXPANDING NEW TECHNOLIGIES - SOLAR

OUTCASTS

FLOATOVOLTAICS

- The **dam's reservior** and **landlocked water** bodies like ponds and lakes would be ideal.
- **Offshore floatovoltaics** also has its own advantages, as they have infrasturcture ready for energy transmission.

POTENTIAL ZONES IN KENYA?

LAKE
Victoria Lake
Turkana Lake
Naivasha Lake

RESERVOIRS
Thika Dam
Masinga Dam
Kamburu Dam
Sondu Miriu Dam

COASTAL AREAS
Indian Ocean

MORE LAKES
Nakuru Lake
Baringo Lake
Bogoria Lake

AGRIVOLTAICS

- To be put in large commercial farmlands. Researchers are looking into which panels and setups would be best for which crop.
- Some plants need **bigger gaps between the panels**.
- Corn and wheat would **need taller solar panels** ones.
- While shrubby soybeans would be fine with a more squat variety.

POTENTIAL ZONES IN KENYA?

FARMLAND

GARDENS

VINEYARDS

ORCHARDS

OFF GRID < ~ > CENTRAL GRID

CURRENT SCENARIO

- **Kenya Power (KP)** is the sole electricity distribution company in Kenya. It operates **interconnected grid, and also several off-grid stations** in the northern regions.
- As of August 2022, KP has **over 9 million customers**, up from 3.6 million in 2015.
- KP has nearly **tripled access to electricity** over the last 11 years, from **26%** of households in 2011 to **76.54%** in 2022.
- This is well above the global average of 86% and makes **Kenya one of the fastest-electrifying** countries in the world.
- **The Rural Electrification Authority (REA)**, helping to move rural electrification from **4% to 68%** of rural households since its inception in 2006.
- The REA has achieved this by connecting over **60,000 public facilities** (mostly primary schools) around the country and household consumers within **600 meters of those facilities.**
- The REA is working to promote use of renewable energy in rural areas. In 2021, the REA launched the **Last Mile Connectivity Project**, which aims to provide access to electricity to all Kenyans by 2022.

GOVERNMENT EFFORTS?

- The Kenyan government is committed to increasing access to electricity for all Kenyans. In 2019, the government launched the **Scaling Up Renewable Energy Program (SURE)**, which aims to provide access to electricity to an additional **2 million households by 2022**.

- SURE is investing heavily in off-grid electricity, with a focus on solar home systems and mini-grids. The program has already provided **solar home systems to over 1 million households** and **mini-grids to over 100,000 households**.

Kenya Power

Rural Electrification Authority (REA)

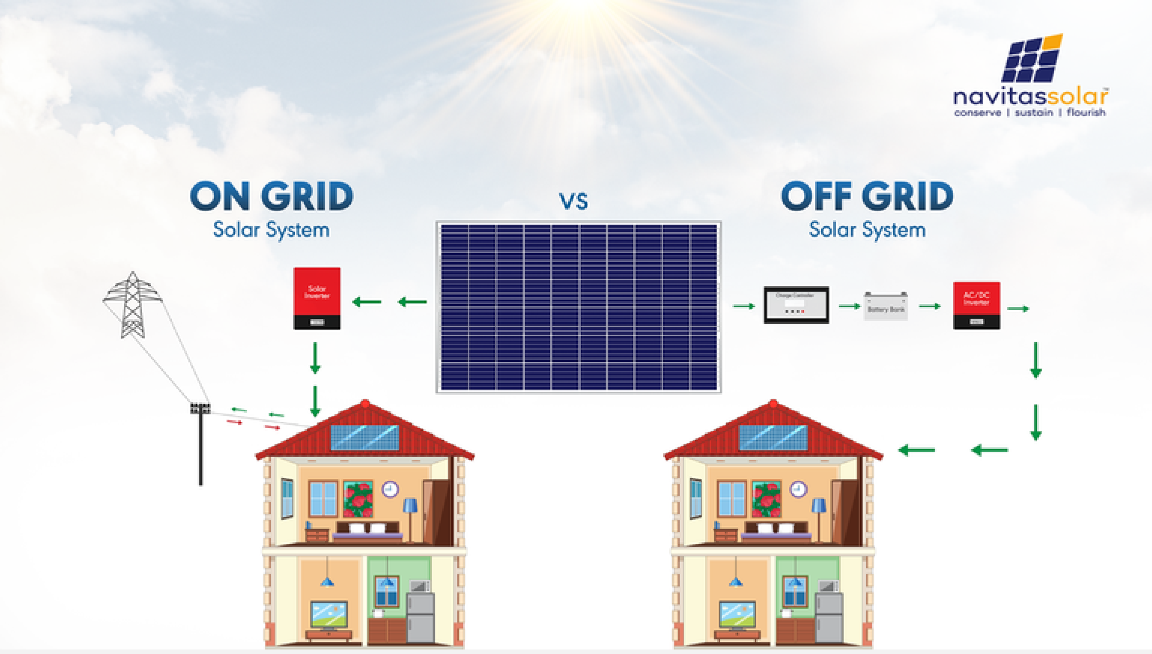
OFF GRID < ~ > CENTRAL GRID

OUTCASTS

- Off-grid solutions do provide energy accessibility, but connecting them to the grid, will also improve its output over the long run.

What problems could OFF-GRID plants face?

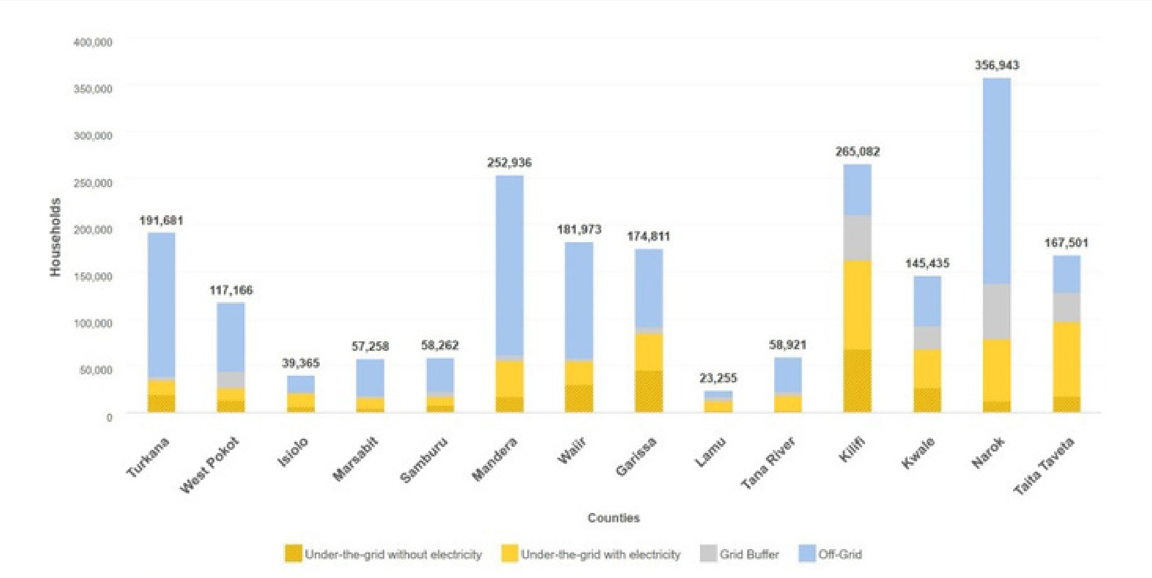
- The **energy supply** throughout the day and throughout the year **varies** in case of solar, wind and hydro powerplants, **causing loss of excess energy in peak hours**, and lack of energy at certain times.
- Increasing the electricity generation capacity of the plant in future would be **expensive due to requirement of more batteries**.
- Battery-Life of every energy storage **deteriorates over time**, **increasing the maintainance cost** and decreasing the electricity output (After many years).
- Sudden equipment failure or damage to the plant due to a disaster or an accident **may cause long term power outages**.



What will happen if we connect OFF-GRID to ON-GRID:

- **Reduce** the requirement of **batteries**.
- Excess energy in **peak hours** would be supplied **into the grid** and excess **energy demand will be covered** by the electricity from the grid.
- This will allow for r**egular mainatainance check of off-grid** systems and provide electricity in case of **emergencies** like sudden equipment failures.

The Data clearly shows that **Majority of Kenyian cities** are still dependent on OFF Grid Systems, **which is not favourable** for renewable energy sources.



Source: Power Africa Geospatial Analysis

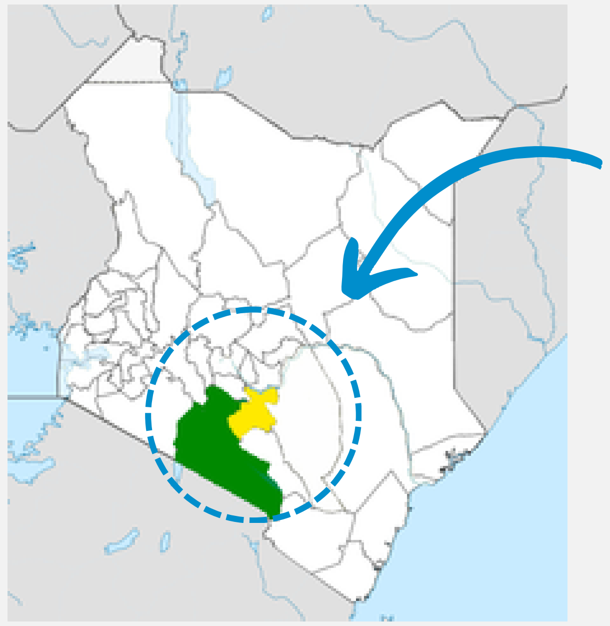
SETTING UP SOLAR PLANTS - SECONDARY

OUTCASTS

FINANCE MODEL - AGROVOLTICS

FINANCIAL FACTORS

- **Machakos County:** This county is located in Eastern Kenya.
- Machakos County in Kenya has a **high solar irradiance**, with an average of **2130 kWh/m2 per year**.
- It is a major producer of maize, **sorghum**, **beans**, and millet.



POTENTIAL ZONES

COST FACTORS

Solar panels	$500,000-$1,500,000
Mounting structures	$100,000-$300,000
Inverters	$50,000-$150,000
Other electrical equipment	$50,000-$150,000
Land preparation	$50,000-$150,000
Planting	$50,000-$150,000
Irrigation	$50,000-$150,000
Total	$1,000,000-$3,000,000

Setup Cost - 1 million to 3 million

the Agrovoltics plant could produce - 200 - 600 MW of electricity.

Here the finances is shown only for the Machakos County of Kenya.
The total Energy and Revenue can be predicted further.

ROI CALCULATIONS

Size of agrovoltaic plant (MW)	Estimated number of households powered
200 MW	1.14 million
400 MW	2.28 million
600 MW	3.42 million

A **lot of Investment** would be done on this innovative approach. As this Agrovoltics also **support beans and sorghum production** and provide enough electricity to power a lot of homes.

OUTCASTS

FINANCE MODEL - FLOATOVOLTICS along with HYDROELECTRICITY

CASE STUDY : EXISTENCE

The run-of-the-river hydroelectric power plant went operational in 1981. It is owned and operated by Kenya Electricity Generating Company (KenGen). The plant has a **nameplate capacity of 40 MW.**

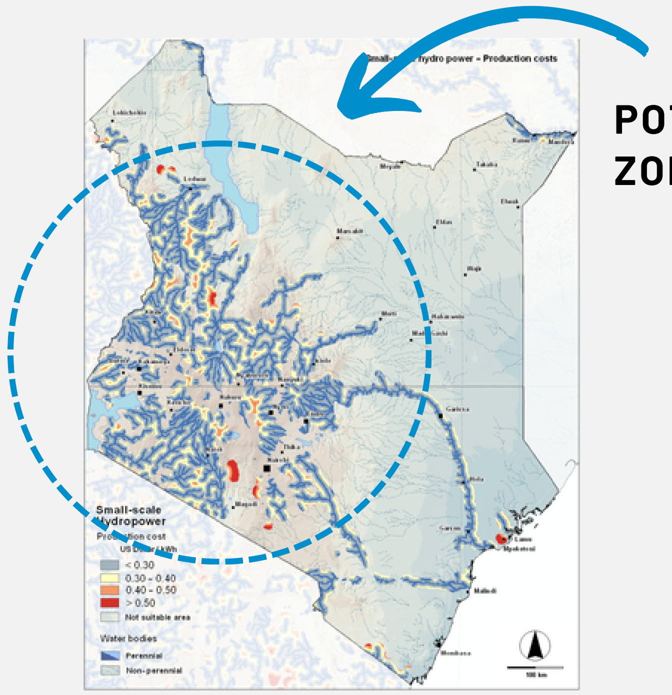
IMPLEMENTATION

- Solar panels - $**0.5-1 million per MW**
- Inverters - $**0.25-0.5 million per MW**
- Floatation system - $**0.1-0.2 million per MW**
- Installation - $**0.1-0.2 million per MW**

ADDITIONAL COSTS

- Routine Maintenance (2-5%) - **40,000 - 100,000 USD**
- Corrective maintenance (1-2%) - **20,000 - 40,000 USD**
- Insurance (1%) - **20,000 USD**
- Security (0.5%) - **10,000 USD**
- Grid Connection Fees (0.5%) - **10,000 USD**

Total Maintenance and running costs :
105,000 - 285,000 USD for 1 MW



POTENTIAL ZONES

Cost of Constructing a Floatovaltics Basin on the Tana River Basin - **2,000K - 3,000K USD per per MW**
For a 100 MW system, the total cost would be $200-300 million.

Tana River Basin Have a Hydroelectricity Potential of **2,000 MW**
Along with Floatovoltics, the overall renewable system will be Powering effectively all the year.

Here the finances Masinga Dam Reservoir of Kenya.
The total Energy and Revenue can be predicted further.

MASINGA DAM RESERVOIR

OUTCASTS

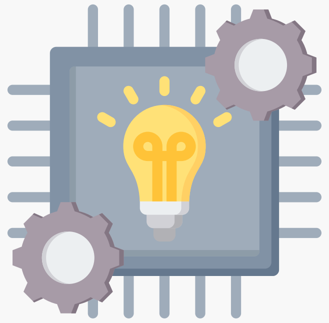
KENYA
PHASE PLAN

2025 - 2027 | **2028 - 2031** | **2032 - 2035**

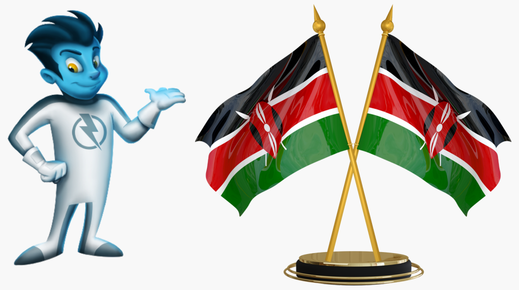
OLD KENYA

PHASE 1 + PHASE 2

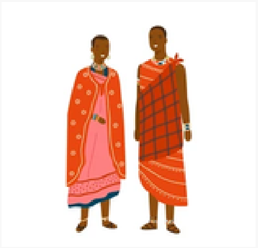
TECHNICAL ADVANCEMENTS



KENYA AT EVEN NEW HEIGHTS



TRIBAL AWARENESS



CLOUD METERING

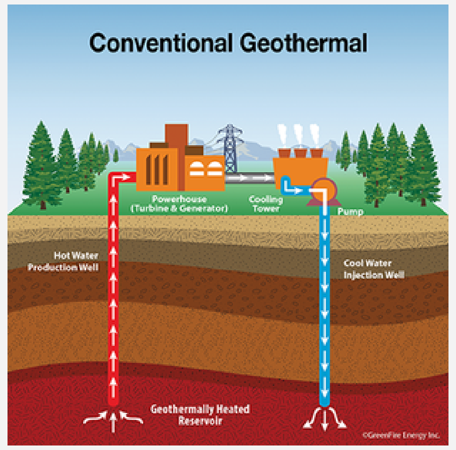
RESEARCH FOR NEW MARKET INNOVATIONS

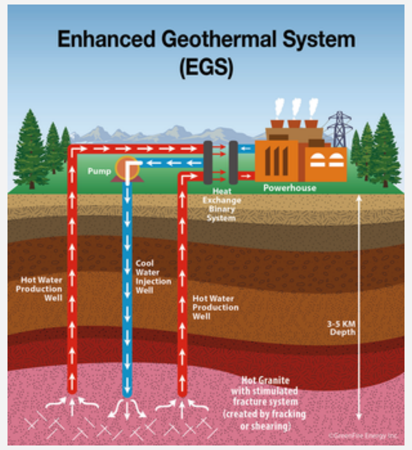
PLAN FOR ADVANCEMENTS

OUTCASTS

GEOTHERMAL (EGS)

- We may approach the model used by Australia, known as **EGS** (Enhanced Geothermal System).
- This model **reduces the cost** for establishment **by 90%.**





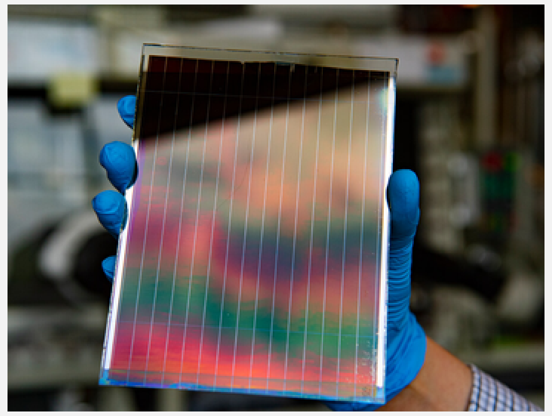
Cooper Basin, Australia

Reduced CO2 emssions by **110,000 tonnes per year.**

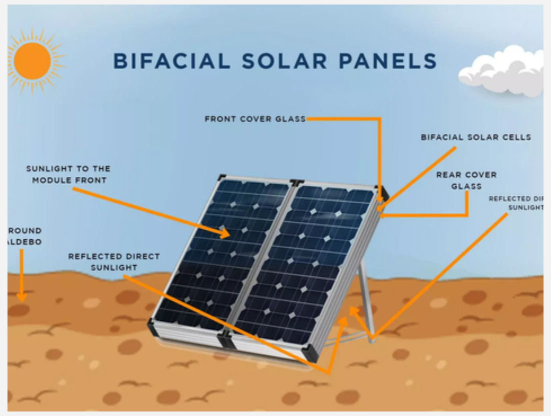
$100 million in revenue for the local economy

SOLAR (AGRO + FLOATO)

Perovskite Solar Cells



Bifacial Solar Panels

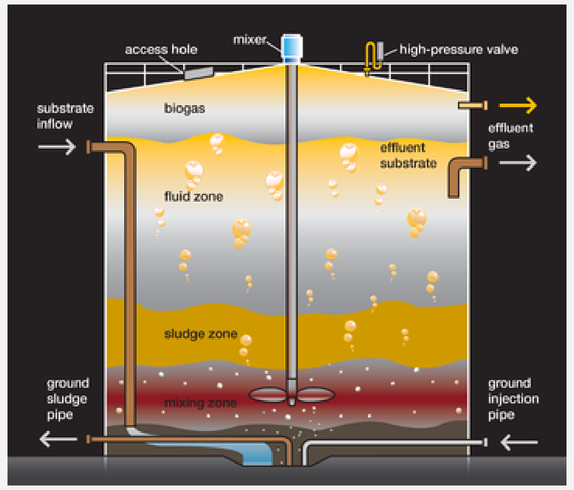


Perovskite solar cells have shown remarkable progress in recent years with rapid increases in efficiency, from reports of about **3% to over 25%**

Bifacial solar cells have between **22 - 23%** efficiency, though this depends on the type and condition of the cells used. **They are far more efficient in capturing sunlight** than monofacial panels.

BIOGAS & ELECTRIC STOVE

- High-Performance **Biogas Digestor**



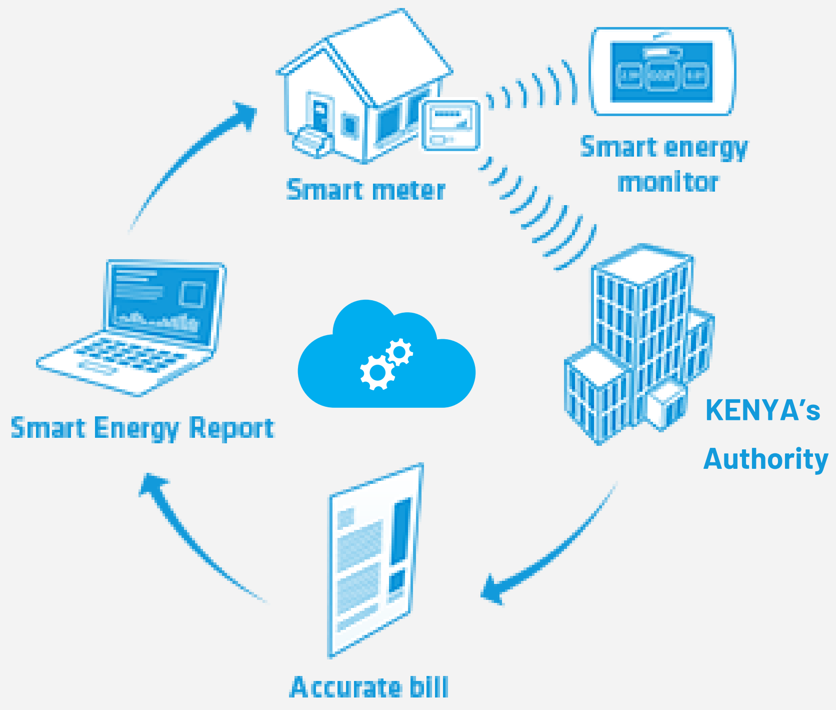
- Electric Stove with **built in Air-Fryer &**
- **Self Cleaning** Electric Stove

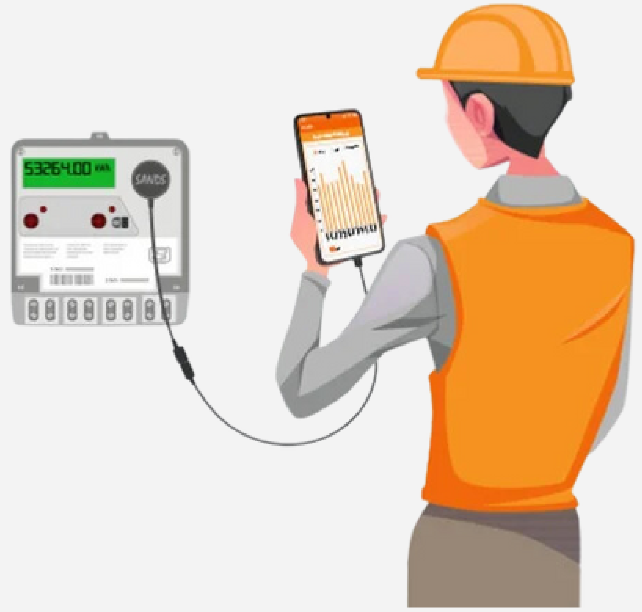
OUTCASTS

SMART GRIDS

OVERVIEW

- A **cloud-based smart metering infrastructure** (SMI) for distribution grid services and automation is a system that uses **cloud computing to collect, store, and analyze data from smart meters**. This data can then be used to improve the efficiency and reliability of the distribution grid.





INSPIRATION

- **Maharashtra State Electricity Distribution Company** (MSEDCL) is using cloud-based SMI to manage its pre-paid electricity meters, reducing revenue losses and improving customer satisfaction.

- **Gujarat Urja Vikas Nigam Limited** (GUVNL) is using cloud-based SMI to implement a demand response program, reducing peak demand and saving money on energy procurement.

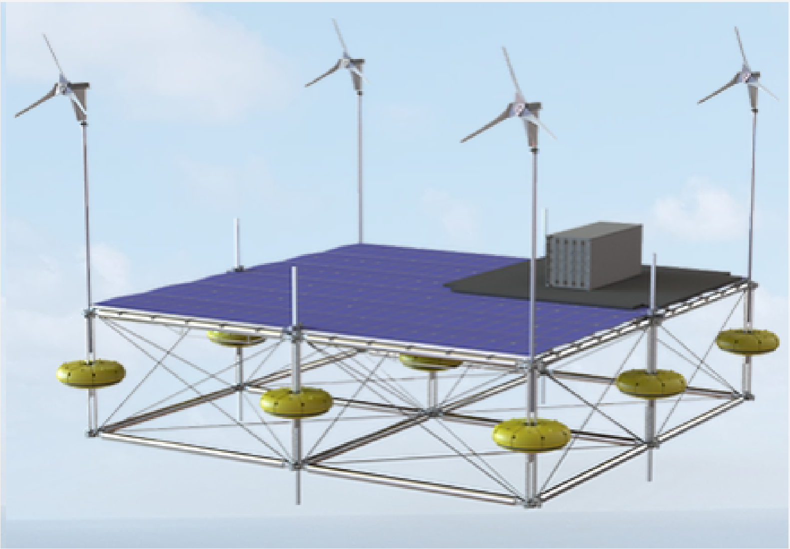
- Reduced **electricity theft** in Mumbai and Gujrat, India significantly.
- A survey of consumers in Mumbai found that **90% of consumers are satisfied** with cloud electricity metering and that they have found it to be helpful in **managing their energy use**.

RESEARCH ON NEW MARKET INNOVATIONS :

OUTCASTS

SINN POWER

- **Benefits:**
  - Modular and scalable.
  - Designed for **harsh maritime** environments.
  - **High yield** due to **bifacial PV modules.**
  - **Higher** efficiency due to **cooling effect.**
  - **Hybrid**: a combination of **solar, wind and wave generating elements possible.**
  - Heavy Duty Platform as an add-on possible



This may provide very astonishing results, but requires singificant capital for genaration thats why we have put it after major phases

POTENTIAL ZONES

- Oceans
- High Seas
- Supply of remote islands
- Aquafarming

INVESTMENT DONE IN PHASE - 3

OUTCASTS

ADVANCEMENTS IN EXISTING PLANTS

- The cost required for the minor advancement of Electric Stove, Solar energy is included in the M/O costs.
- Further the cost required in advancement of **Geothermal** is included in **Packages Finances.**
- And for the Whole Implementation **Government is required** to expand the ideas and bring investment in future Years.

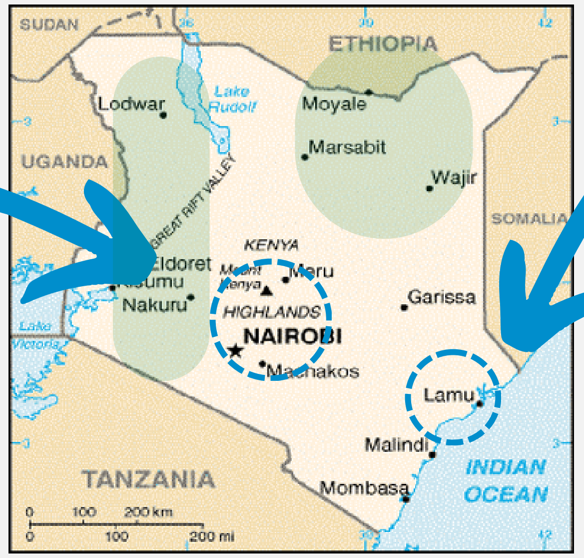
SMART GRIDS

- Once When Whole Kenya is benefited by the central grid facilities. Government needs to look after the Smart Grids.
- For Now Lets see a **basic Model for Nairobi, Kenya.**
- Cost of Installation = 100,000 USD per km sq.
- Area of Nairobi (Mostly the Populated Area) = 600 km sq.(approx)
- Therefore **total cost = 60,000,000 USD + Taxes and Insurances + M/O costs.**

ADVANCED TECHNOLOGY

- The Sinn Power idea is for **future consideration of Kenya**. Once they tackle their all their minor issues.
- But We want that this Project Must Start from now such that the future IPPs or Even Govt. will look forward to complete it.
- Around **40,000,000 USD** is invested from our capital to start this project on the coastal region.

POTENTIAL ZONES



The Potential Region - **Lamu Archipelago**

KENYA

PHASE PLAN - FINANCE

OUTCASTS

PROJECTS	TARGET POPULATION	Total Maintenance cost for 10 years (in $ million)	Total Estimated Cost (in $ million) for 10 years	Return (in $ million) for 10 years	Return On Investment in %	Cost to Government (Subsidy, investment etc.) in $ million
GEOTHERMAL APPLICATION	People living and the industries across the Whole **Rift Valley, Kenya**.	M/O costs = **75,000,000 USD**	Expansion + Package cost = **150,000,000 USD** Setup + M/O cost = **1,150,000,000 USD**	Annual Return = **195,000,000 USD/yr**	**approx 15 %**	The cost of **connecting the central grid** to the plant + Community service Cost
SOLAR AGRO + FLOATO	Solar Farms - **Rural Community**. Agro - Large and Suitable **FarmLands** Floato - across **HydroPower Plant.**	Total M/O Costs = **120,000,000 USD**	Solar Farms - **500,000,000 USD** Agrovoltics - **50,000,000 USD** Floatovoltics - **250,000,000 USD**	Solar Farms = **0 USD** Agro = **12,500,000 USD / year** Floato = **37,500,000 USD /year**	Agro = **25 %** Floato = **15 %**	The Cost of **Connecting the Central Grid** to various farms and plants. And **Future Harnessing** this technologies.
BIO GAS	BIO GAS - **Rural** Population Electric Stove - **Urban** Population(who require almost more than 1.2 kWh)	Total M/O costs = **105,000,000 USD**	Setup Of Dome - BioGas Plant = **150,000,000 USD** Industrial Plant **180,000,000 USD** Electric Stove (PPP Setup investment) **70,000,000 USD**	Dome - BioGas = **0 USD** Industrial Digestor = **1,000,000 USD /yr** Electric Stove = **1,750,000 USD / yr**	BioGas = **0 ROI** Industrial Digestor = **35 %** Electric stove = **14.3 %**	Government will **cut down the price of first 40 units** of electricity generated from Electric Stove by Families.
CENTRAL GRID + OFF GRID	All the People whose house is **not** connected with **Central Grid.**	Source Griding Costs = **200,000,000 USD**	**0**	**Govt. Project**	**Govt. Project**	**Government is responsible** for this development, as of now almost 30 % of rural population lag this.

KENYA
PHASE OVERALL FINANCE

OUTCASTS

2025 - 2027 | 2028 - 2031 | **2032 - 2035**

Our Overall Capital Provided - **3,084,653,730 USD**

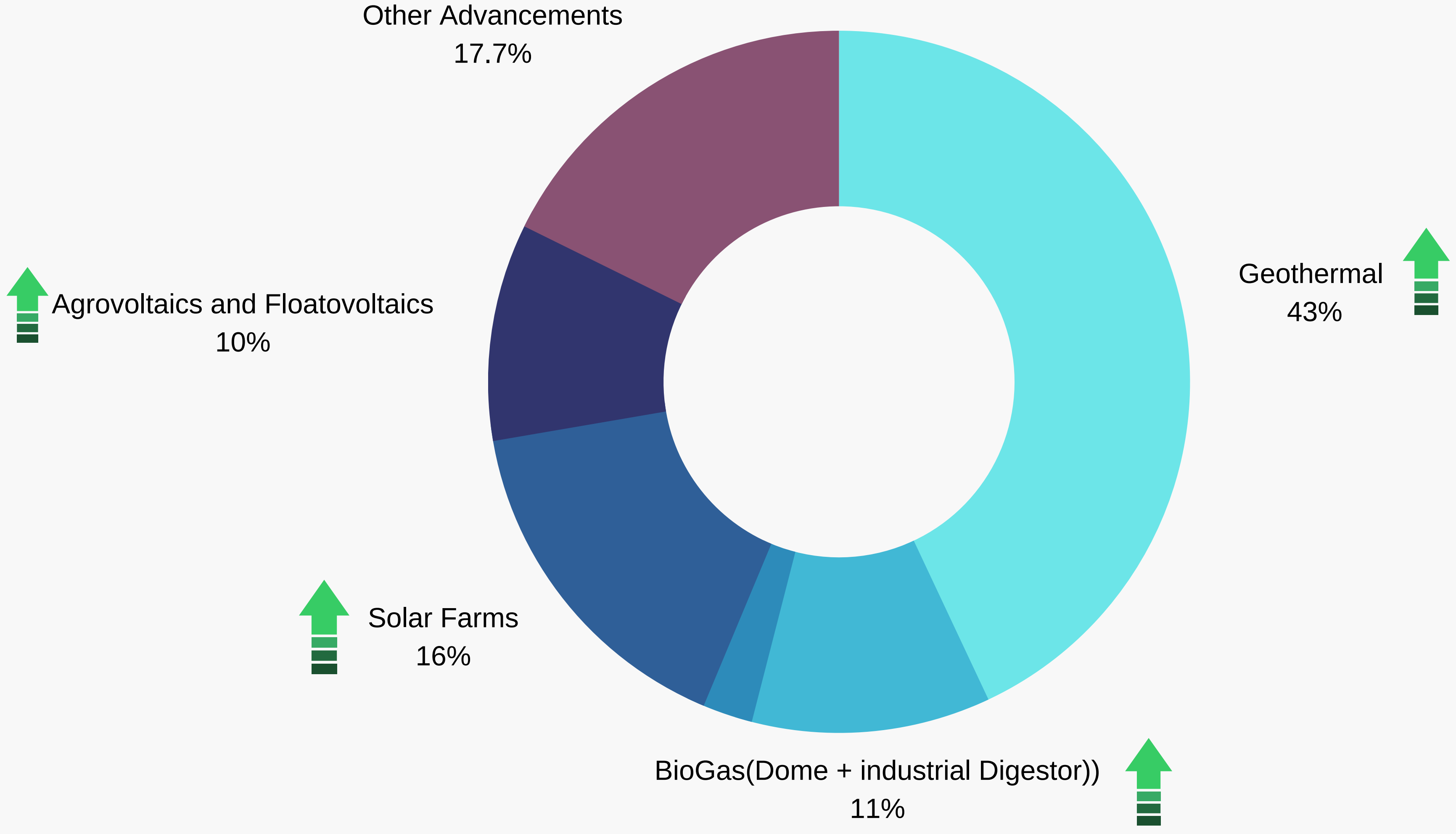
Team Outcast's plan aims to boost Kenya's Electricity Availibility to cross the **8,000 MW capacity.**

The following tariff rates was taken in considerance -

Table 1: Electricity tariff rates (2018 and 2023)

	Tariff rates 2018 Ksh/Kwh	Current tariff April 2023 Ksh/Kwh
Domestic customer 30-100 KWh	21.99	26.10
Domestic customer category >100 kWh	27.92	31.75

The M/O cost includes all the taxes and insurances required to all. And the minor inclusive cost have all been considered at many points.



OUR CAPITAL INVESTMENT

KENYA
OVERALL PHASE

	PHASE I	PHASE II	PHASE III
Years	2025 – 2028	2028 – 2032	2032 – 2035
Investments	2,200,000,000 USD	620,000,000 USD	264,653,730 USD

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Overall Energy Capacity (mW)	2990	3120	3560	3860	4100	4400	5130	5800	6540	7300	8000+

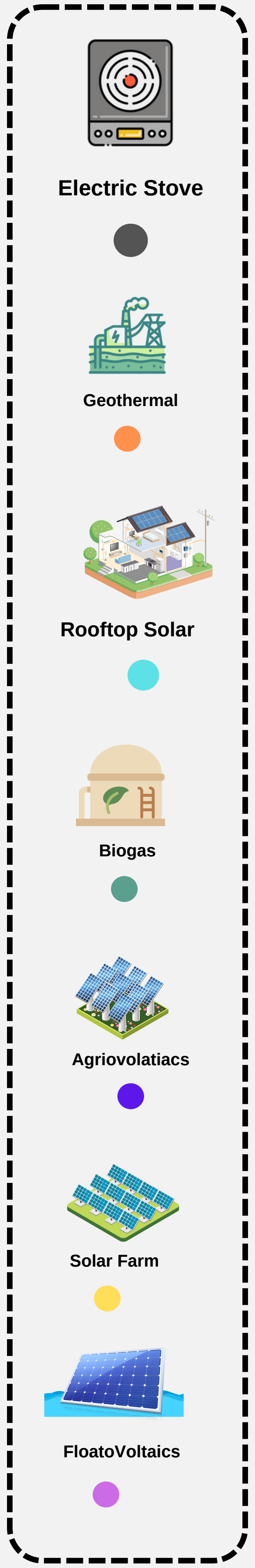
The M/O cost includes all the taxes and insurances required to all. And the minor inclusive cost have all been considered at many points.
The immediate spend-up of x% of the entire budget within the first 3 years is to ensure that immediate action
is taken to make energy accessible and infrastructure available for further development of nation and its facilities.

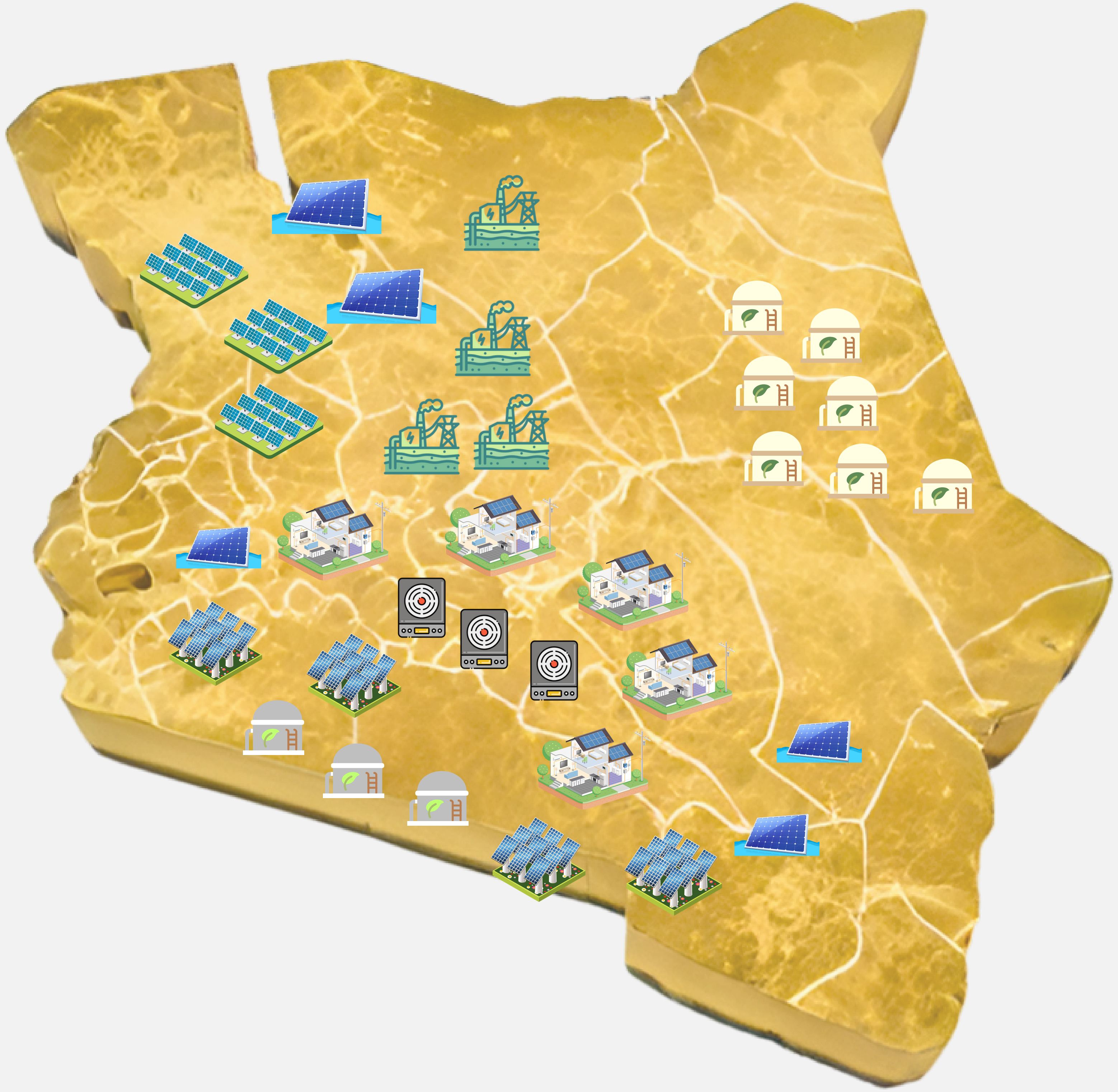
Further expenditure will be mainly focused on inclusion of latest technologies and expanding the grid to match up with the increasing energy demand.
At last, the investment in phase-3 will make Kenya a leading Country in the energy sector,
and its successful implementation would leave huge impact, not only in Kenya, but in entire of Africa and all of the World.

KENYA INFOGRAPHICS

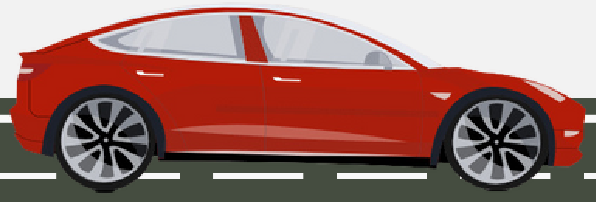
OUTCASTS

LEGENDS USED





This would be the setup of Kenya's Map, once our 10-Year Plan is overall implemented.



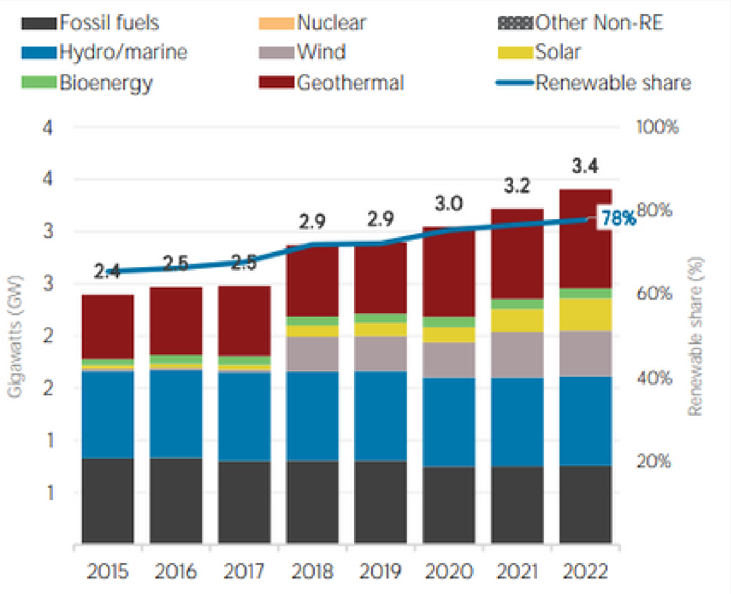
ENERGY OVERVIEW | COMPARITIVE ANALYSIS | PHASE PLAN 01 - 02 - 03 | IMPACT ON KENYA | FEASIBILITY IN BANGLADESH | IF OUR PLAN GOES SOUTH | CONCLUSION

IMPACT ON KENYA

KENYA

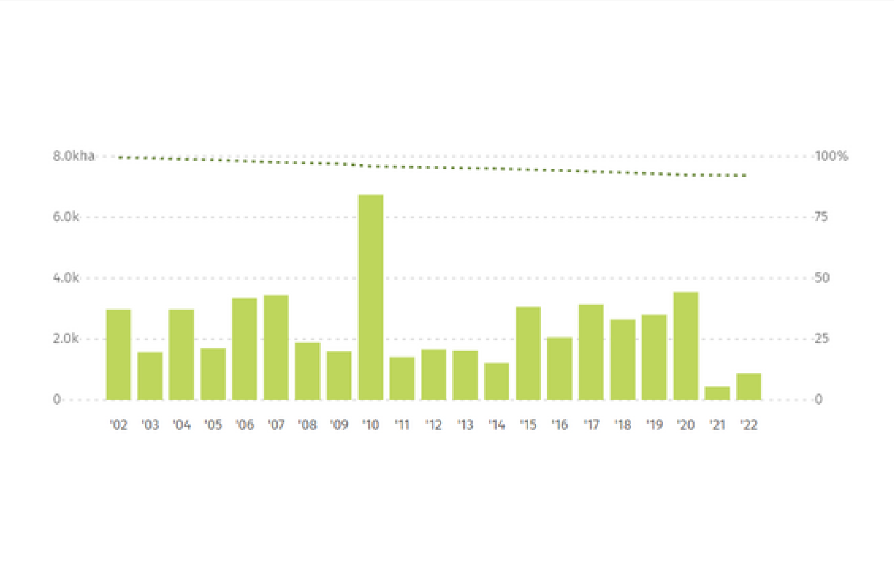
IMPACT ON ENVIRONMENT

Reduction of imports and usage of fossil fuels



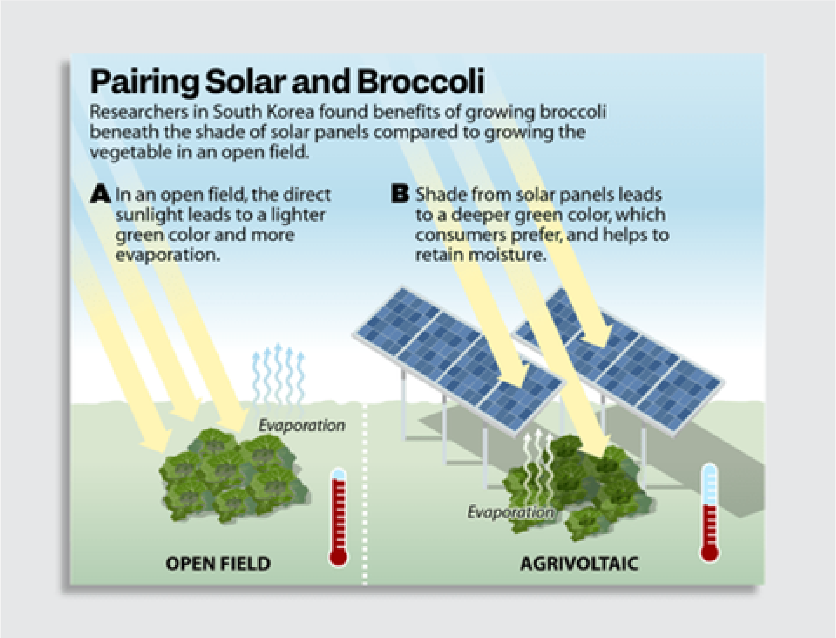
As usage of renewable energy sources increases demand for fossil fuel will directly decrease.

Decrease in Deforestation Rates



As consumption of fire-wood reduces due to utilization of electric stoves and clean cooking fuels, the deforestation rated would decrease.

Increase in farm produce and decrease in water usage



Usage of agrovoltaics and floatovoltaics decreases the rate of evaporation directly improving the moisture content as well as quality of farm produce

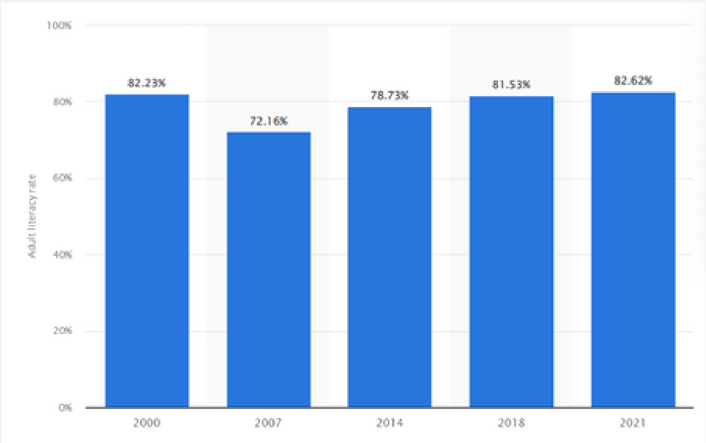
IMPACT

KENYA

IMPACT ON COMMUNITY

OUTCASTS

Improvement in Education Facilities

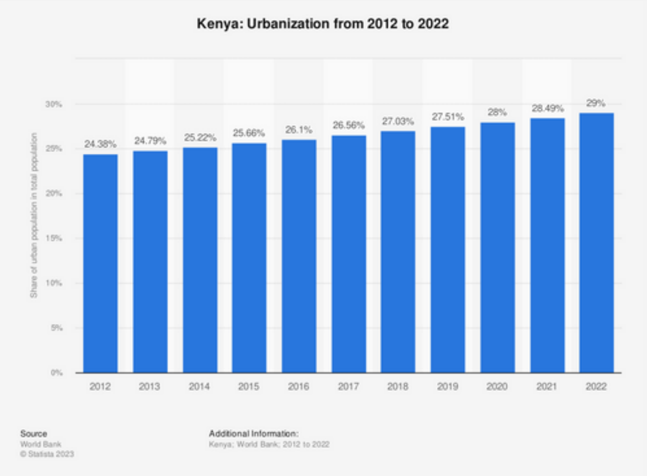


Improved energy availability in Kenya would **enhance education facilities by providing consistent power for lighting**, **technology, and resources**, enabling better learning conditions, expanded access, and modernized teaching methods.

Improvement of Public Facilities in Rural Areas

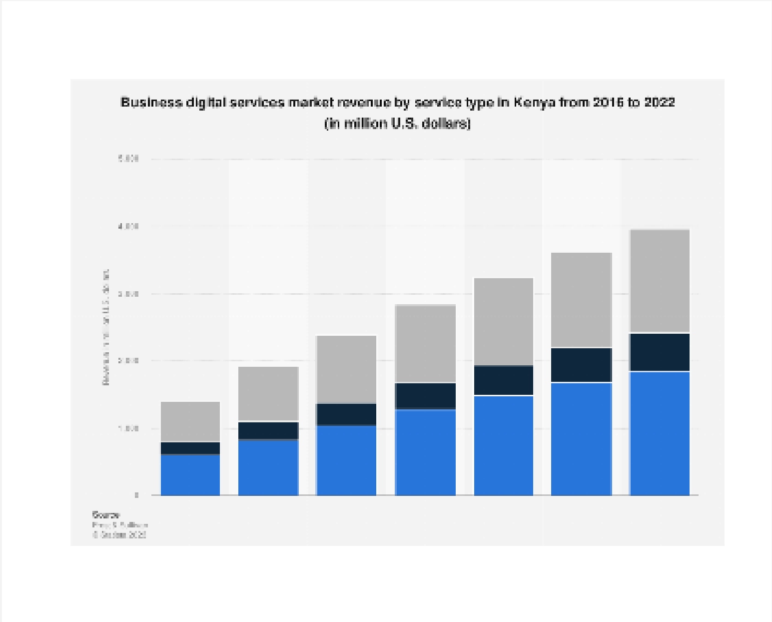
Energy availability in rural Kenya enhances public facilities by **powering clinics, schools, and water supply systems.** It facilitates better healthcare, education, and overall living standards, promoting rural development.

Increase in Urbanisation



Energy supply supports **urbanization in Kenya by enabling the development of infrastructure, industries, and services** in urban areas. It attracts investment, creates job opportunities, and improves living conditions, driving urban growth.

Inclusion of cloud computing to have better control



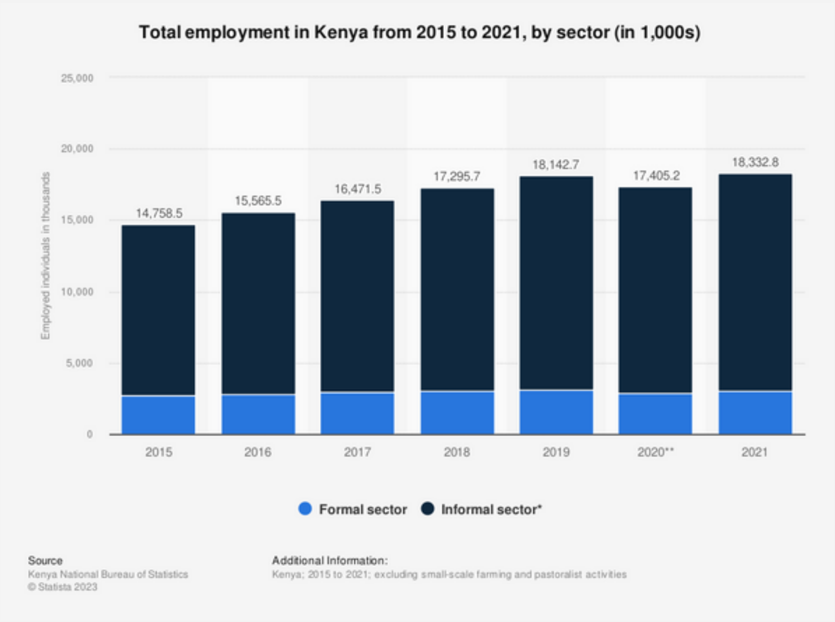
Energy availability in Kenya is essential for the expansion of cloud computing, **as it powers data centers and supports the necessary infrastructure**, ensuring reliable and scalable digital services.

KENYA
IMPACT ON ECONOMY

OUTCASTS

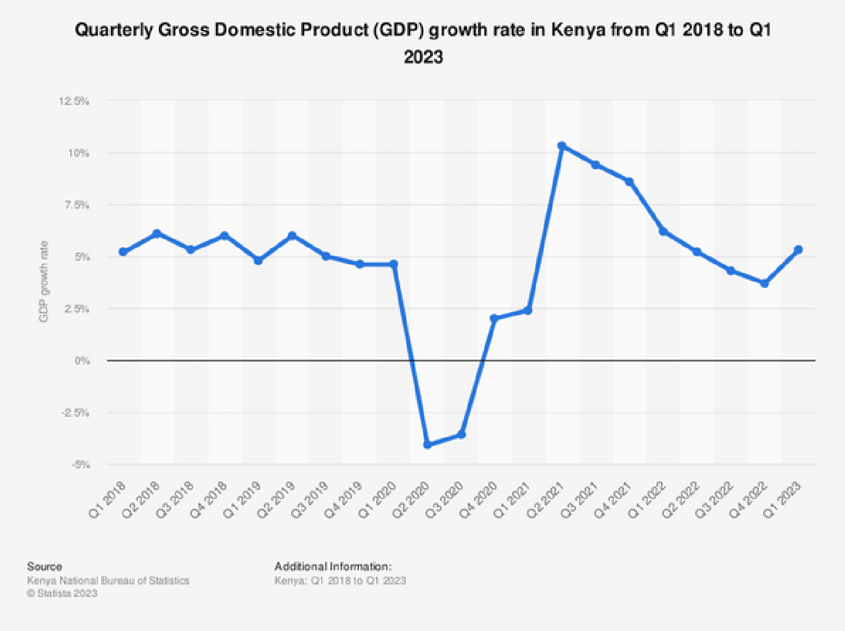
Ref: www.tbsnews.net

Creation of new jobs



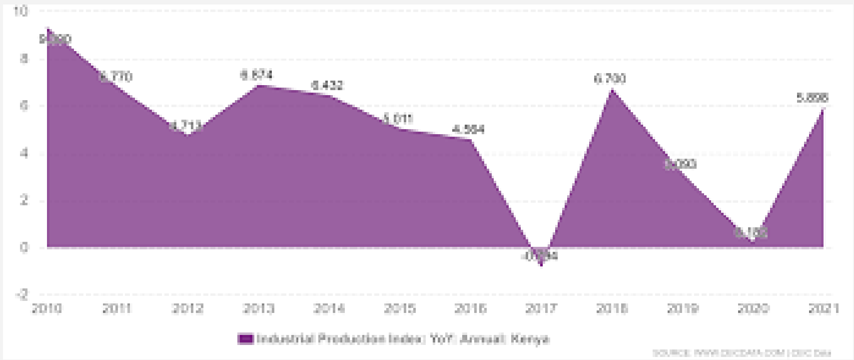
Energy availability in Kenya stimulates economic growth by powering industries, leading to job creation. It enables businesses to thrive, increasing employment opportunities across various sectors.

Economic boost in energy industry



Energy availability bolsters the energy industry in Kenya by attracting investment, promoting exploration, and supporting efficient production. This boosts economic growth, increases energy sector revenue, and reduces energy costs.

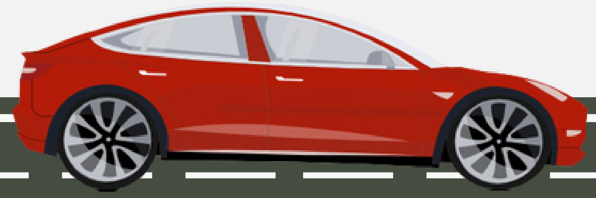
Increase in manufacturing and exporting capabilities



Energy availability enhances manufacturing capabilities in Kenya by providing consistent power for machinery and processes. This enables increased production, product quality, and competitiveness, spurring industrial growth and economic development.

Ability to develop modern facilities having latest technologies

Energy availability facilitates the development of modern technologies in Kenya by powering research, innovation, and technology infrastructure. It supports the growth of the tech sector, fostering innovation and economic advancement.



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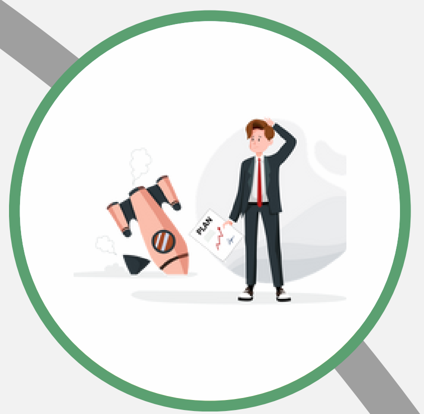


FEASIBILITY IN BANGLADESH

OUTCASTS

BIO - ENERGY

SWOT ANALYSIS

STRENGTH

- With **70% of rural residents lacking access to natural gas** connections, they rely on expensive wood and kerosene stoves.
- Biogas plants provide a **promising alternative by saving forests** and **reducing health risks**, particularly for rural women.
- Bangladesh has **abundant biomass resources**, such as agricultural waste, livestock manure, and municipal solid waste, which can be used to produce biogas.

WEAKNESS

- **Limited Infrastructure**: The implementation of biogas may face challenges in areas with limited infrastructure for the construction and maintenance of biogas digesters.
- **Public Awareness:** Lack of awareness and understanding of biogas technology among the public may hinder its widespread adoption, requiring educational initiatives.
- **Initial Investment Barriers:** High initial costs for setting up biogas systems might be a deterrent for individual households or farmers, impacting the widespread implementation.

OPPURTUNITIES

- **Energy Poverty Reduction**: Biogas offers affordable and clean energy for rural households, addressing electricity and cooking gas shortages.
- **Public Health Improvement**: As a clean-burning fuel, biogas reduces indoor air pollution, positively impacting public health.
- **Job Creation**: The biogas sector creates jobs in manufacturing, installation, production, and distribution, bolstering the economy and reducing unemployment.
- **Foreign Investment Attraction**: Growing interest in renewable energy, particularly biogas, attracts foreign investments, expediting technology development.

THREATS

- The price of **fossil fuels has been declining** in recent years, which could **make biogas less competitive**.
- There is a **lack of awareness and knowledge** about **biogas** among many Bangladeshis.
- **Power outages** and other disruptions to the electricity grid can **disrupt biogas production**.
- Climate change could also impact biogas production by **affecting the availability of biomass resources** and **temperature conditions.**

FEASIBILITY IN BANGLADESH :

OUTCASTS

ELECTRIC STOVE

STRENGTH

- Electric stoves are **more energy-efficient than traditional gas stoves**, which is important in Bangladesh where electricity prices are relatively high.
- **Electric stoves produce zero emissions**, which can help to improve air quality in Bangladesh's urban areas, which are often plagued by air pollution.
- Electric stoves **reduce the reliance on fossil fuels** like natural gas or LPG, which can contribute to energy security and environmental sustainability.

WEAKNESS

- Electric stoves require a **reliable electricity supply**, which can be a challenge in some parts of Bangladesh where power outages are common.
- The **cost of electricity in Bangladesh is relatively high**, which can make electric stoves more expensive to operate than gas stoves, especially for Bangladeshis who consume a lot of electricity.
- **Transitioning to electric stoves may necessitate** significant investments in electricity infrastructure, to ensure consistent and affordable power supply.

SWOT
ANALYSIS

OPPURTUNITIES

- The Bangladeshi **government is promoting the use of electric stoves** through various subsidies and incentives.
- There is a **growing demand for electric stoves in Bangladesh**, both from urban and rural households.
- Electric stoves can **help to reduce Bangladesh's dependence on imported fossil fuels**, such as liquefied petroleum gas (LPG).

THREATS

- The **price of electricity in Bangladesh is relatively high** and could continue to rise in the future, which would make electric stoves **more expensive to operate**.
- The Bangladeshi **electricity grid is vulnerable** to disruptions from natural disasters and other events, which could interrupt the use of electric stoves.
- Some Bangladeshis **may be hesitant to adopt electric stoves** due to cultural norms or preferences.

SOLAR ENERGY

SWOT ANALYSIS

STRENGTH

- 58% of rural households in Bangladesh are energy poor and have no access to electricity.
- Bangladesh has **high potential for solar energy**, as it receives **4.0 to 6.5 kWh/m2** of solar radiation per day.
- **Solar home systems (SHS) are a solution** to this problem, as they are free from transmission problems and **do not increase GHG emissions**.
- Abundant solar energy in Bangladesh **can reduce traditional fossil fuel-based** power production and **ensure a green environment** for the future.

WEAKNESS

- **Difficulty of acquiring land:** Due to govt. regulations, agricultural land cannot be used for solar power. The country is with fertile agricultural land, and unused land is not easily available.
- **Low-quality solar panels:** The Bangladesh market has solar panels with an efficiency of 10-12%, while modern solar panels used globally have an efficiency of up to 22%.
- **Lack of coordination between ministries:** Lack of effective collaboration and coordination between the ministries, government dept.This is observed in approval process for licenses and permits for setting up power plants.

OPPURTUNITIES

- **Increasing energy demand:** The growing population, industrialization, and urban growth are driving up energy demand. Here we can introduce Solar Energy
- **Availability of foreign investors:** Many countries are interested in investing in renewable energy in Bangladesh, which can provide funding and expertise for solar energy projects.
- **Decreasing cost of renewable equipment:** The cost of solar panels and other renewable energy equipment has decreased significantly in recent years, making it more affordable to develop solar energy projects.

THREATS

- **Dominance of fossil fuels:** The Bangladeshi government still heavily subsidizes fossil fuels, which discourages investment in renewable energy.
- **Lack of legal defense for technology innovation:** Bangladesh's intellectual property rights framework is underdeveloped, making it difficult to protect and commercialize new solar energy technologies.
- **Discontinuity of energy policies:** The Bangladeshi government's energy policies have been inconsistent, which creates uncertainty and risk for investors in solar energy projects.

OUTCASTS

GEOTHERMAL ENERGY

STRENGTH

- **Abundant geothermal resources** in the **Ganges-Brahmaputra** delta.
- Potential to **generate low-cost, reliable**, and **baseload** electricity.
- Can help to reduce Bangladesh's reliance on fossil fuels and **improve its energy security**.
- Can create jobs and **boost the rural economy**.
- Environmentally friendly source of **energy with low emissions**.

WEAKNESS

- The upfront costs of developing **geothermal energy resources can be high**. This is because it requires **drilling deep wells** to access the geothermal heat.
- Bangladesh has a **limited amount of technical expertise** and experience **in geothermal** energy development. This means that the country **may need to rely on foreign expertise** and technology.
- Bangladesh has **limited infrastructure to support geothermal energy** development. This includes roads, power lines, and water pipelines.

SWOT

ANALYSIS

OPPURTUNITIES

- Bangladesh has **significant geothermal potential**, especially in the Ganges-Brahmaputra delta.
- The Bangladeshi government is supportive of renewable energy and has introduced **number of policies and incentives** to promote geothermal energy.
- There is a growing demand for energy in Bangladesh, which is creating opportunities for the development of **new sources of energy, such as geothermal.**
- Bangladesh has **access to international funding and expertise**, which can be leveraged to support geothermal development.

THREATS

- **Natural disasters**, such as floods and earthquakes, **can damage geothermal infrastructure**
- **Competition** from other renewable energy sources, **such as solar and wind**
- **Resource Uncertainty:** The availability and quality of geothermal resources can be uncertain. **Drilling and exploration costs are high.**
- **Changes in government policies** could discourage geothermal development.

FEASIBILITY IN BANGLADESH :

OUTCASTS

AGROVOLTAIC

POSITIVE IMPACTS

- **Increased Rice Yields:** Studies show that agrovoltaics can boost rice yields by up to 35% by providing shade and wind protection, reducing plant stress. The PV panels also help regulate soil and air temperatures, benefiting rice production.
- **Reduced Irrigation Needs:** Agrovoltaics can cut irrigation requirements by up to 50% as the panels shade crops and soil, reducing evaporation. They also collect rainwater for irrigation.
- **Improved Rural Livelihoods:** Agrovoltaics can serve as an additional income source for farmers by selling excess electricity to the grid. This uplifts rural communities and reduces poverty.

NEGATIVE IMPACTS

- **High Initial Costs:** Agrovoltaic system installation can be expensive initially, although long-term benefits often outweigh these costs.
- **Land Use:** Agrovoltaics require more land compared to traditional agriculture due to PV panel spacing for crop access. Still, they can efficiently combine food and electricity production on the same land.
- **Biodiversity Concerns:** There's concern that agrovoltaics may affect biodiversity, potentially reducing habitat for pollinators. Further research is required to fully understand their impact.

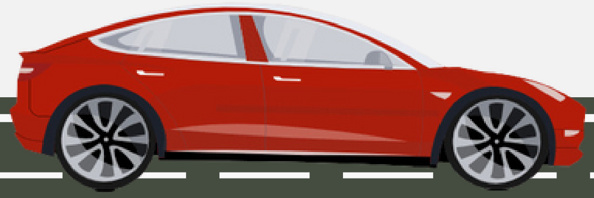
FLOATOVOLTAIC

POSITIVE IMPACTS

- **Land Requirements:** FPVs can be installed on water bodies like lakes, reservoirs, and ponds, conserving limited land resources in densely populated Bangladesh.
- **Higher Efficiency:** FPVs outperform traditional solar panels as water cooling enhances their performance.
- **Aquatic Life Support:** FPVs create habitats for aquatic life and improve water quality by reducing algae growth.
- **Grid Stress Reduction:** FPVs ease pressure on the electrical grid by supplying renewable energy for peak demand.

NEGATIVE IMPACTS

- **Water quality:** In water-scarce Bangladesh, it's crucial to prevent any negative impact on water quality due to FPVs. Panel design should minimize shading and facilitate proper water circulation.
- **Biodiversity:** Preserving the rich biodiversity of Bangladesh is essential. FPV installations should avoid critical areas for fish spawning and migration.
- **Local Communities:** It's important to consider the needs and concerns of local communities when implementing FPV projects to ensure they benefit the people in the vicinity and address any potential social or cultural impacts.



ENERGY OVERVIEW

COMPARITIVE ANALYSIS

PHASE PLAN 01 - 02 - 03

IMPACT ON KENYA

FEASIBILITY IN BANGLADESH

IF OUR PLAN GOES SOUTH

CONCLUSION

IF OUR PLAN GOES SOUTH

PRECAUTION

WHAT IF OUR PLAN GOES SOUTH

OUTCASTS

- Due to variety of renewable energy sources and multiple of subdivisions in them, the risk factor of entire plan being a failure is negligible.
- Division of plan in phases has given us added advantage to our plan of keeping track of every individual project.

- In case if expenses of geothermal exploration goes overboard, the focus may be shifted more towards offshore wind + solar and in case if biomass fails to gather widespread utilization, has utilization issues, then the imported fossil fuels may be used to form an LPG network rather then using the same fuel for electricity generation.

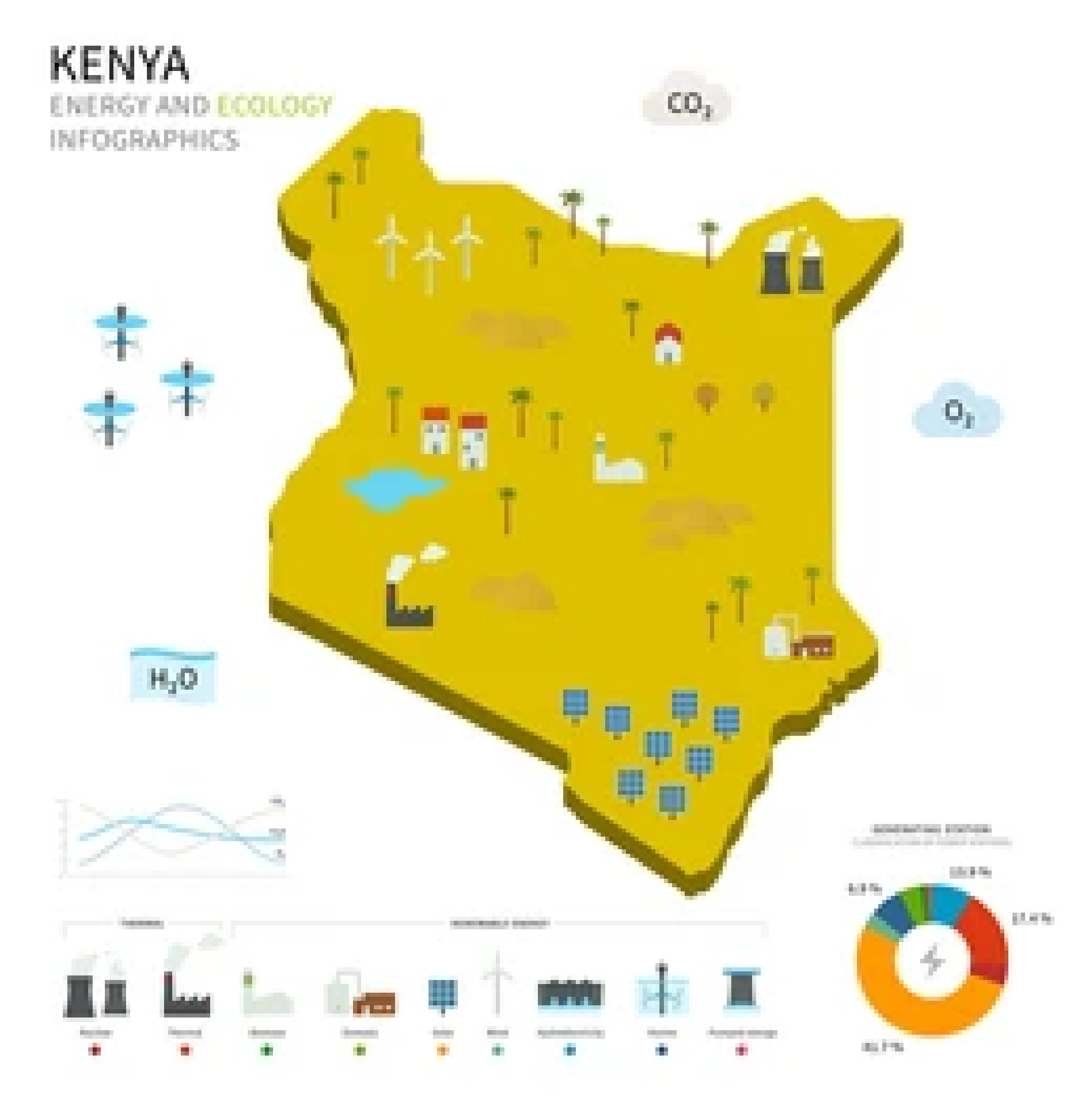
– OUTCASTS +

SOLAR AGRIVOLTAICS

SOLAR FLOATOVOLTAICS

APPLICATIONS GEOTHERMAL

CENTRAL GRID



BIO GAS

ELECTRIC STOVE

SINN POWER

CLOUD METERING

CONCLUSION

OUTCASTS

SUMMARY

PROJECT OUTCAST

CONCLUSION

Kenya's and Bangladesh's energy poverty is not a new issue, it has been pertaining for decades. But not any more. Because its Now or Never. Increasing carbon emissions, melting glaciers and rapid global warming immediate action has to be taken to lower this release and **SWITCH** into the renewables.

$3 BILLION +

Capital Invested

All the capital we have utilized for the benefit of the people of Kenya.

85% +

Electricity generated from renewable resources.

8,000+ MW

Projected energy capacity

The Phase plan will help and guide to reach this mark in 10 year plan.

04 Impact Analysis and Feasibility

What is all this about ?

03 Problems and Solutions

Energy poverty and the way to unlock it.

02 Comparitative Analysis

Likes and Unlikes of Energy Sector of two developing countries.

01 Kenya, Bangladesh and their energy overview.

MORE

SOURCES AND RESEARCH PAPERS

OUTCASTS

DOC

https://docs.google.com/document/d/1vr7anAJvZKSwKrJpWlceUzAVR2wc1cZrZJWHdJgD5r8/edit?usp=drivesdk

OUTCASTS

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OUTCASTS

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CONTENT

TABLE OF CONTENTS

OUTCASTS

Objectice of the Project

General Information Kenya

General Information Banglagesh

Energy Timeline

Energy Mix Kenya

Energy Consumption Kenya

Energy Consumption Banglagesh

Energy Mix Banglagesh

Energy Spectrum

Energy Porverty Indices

Compartives Analysis

Resourced Used- Bangladesh

Resourced Not Used- Bangladesh

Minor Problems

Unique Challenges Kenya

Kenya Expected vs Reality

Major Energy Challenges

Phase 1 Plan

Clean Cooking Fuel

BioGas - Electric Stoves

Finances for Clean Cooking

Implementation & Roadmap

Solar Energy Solution

Finances for Solar

Why Investing in Geothermal

Vast Applications of Geothermal

Finances and Supply Chain

Companies to Approach

Phase 2 Plan

FloatoVoltaic & AgroVoltaic

Connection of OFF Grid

Finance Models

Phase 3 Plan

Plan for Advancements

Smart Grid

Sinn Power

Finances for Phase 3

Overall Finances

Impact on Kenya

Feasiblity in Bangladesh

If our plan goes South

Conclusion