SWITCH ENERGY CASE COMPETITION 2025

TEAM DOUBLE SWITCH

TEAM DOUBLE_SWITCH_

Selected country : Ethiopia

Home Country : India

Team Number : 120

Team Mentor : Professor Raj Kiran

Team Members :

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EXECUTIVE SUMMARY

DOUBLE_SWITCH_

Problem overview

- Low electrification, hydro overreliance heighten drought vulnerability.
- Biomass cooking drives deforestation, pollution, and women's time burden.
- Grid losses, blackouts, and high rural costs persist.

Electrification Solution

- Grid Modernization: Upgrade 30,000 km transmission, 179,000 km distribution, add substations, SCADA, and 5.9M smart meters.
- Off-Grid Solar: Deploy 9.2M SHS for 46M people with PAYG, women co-ops, and phased subsidies.
- Diversify Supply: Add 800MW wind, 1,000MW geothermal, plus battery storage for stability.

Clean Cooking Solution

- Gonzie Stove Plan: Produce 14M stoves by 2035 via local co-ops, training, and quality control.
- Urban LPG: Build Sudan pipeline, use Ogaden gas, reach 8M urban homes by 2035.
- Adoption Model: Apply low, flexible pricing based on India/Africa success.

Financing

- Investment Need: $10.75B (2026–2035) for grid, renewables, and cooking.
- Funding Mix: 32% grants, 41% concessional loans, 17% govt, 1.5% private (WB, GCF, AfDB).
- Financial Target: Peak by 2028, breakeven by 2031, ensure profitability.

Impact

- Universal Access: 95% electrified, 70% clean cooking, 14M stoves installed.
- Social Gains: 50k–75k jobs, 31 $MtCO_2$ cut, 20k lives saved, 2–3 hrs/day saved for women.
- National Outcome: Diversified, resilient energy system with regional trade & gender equity.

CONTENTS

DOUBLE_SWITCH_

DEMOGRAPHIC DATA, ENERGY TIMELINE AND ENERGY ASSESSMENT OF ETHIOPIA

DEMOGRAPHIC INFORMATION

DOUBLE_SWITCH_

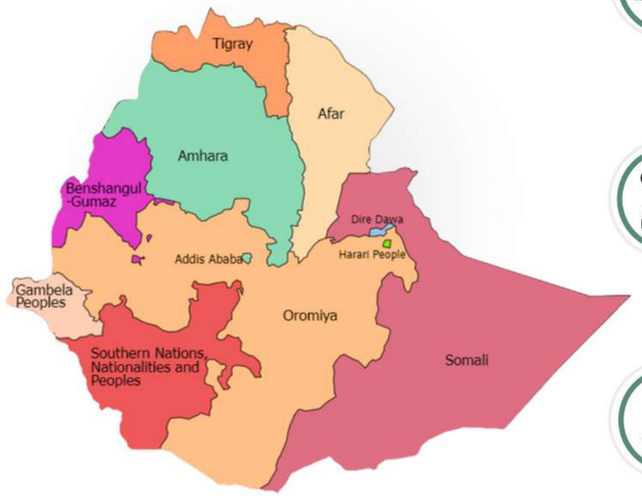
Capital: **Addis Ababa (14 regions)**

Annual GDP: $126.77 Billion (2022)
Per capita GDP: $976 nominal in 2025

*HDI Ranking: **169 out of 193**

Unemployment rate: **18.7%**

Literacy rate: **51.8% overall (57.2% male, 44.4% female)**



Main Economic sectors
Agriculture: 35.8%, Industry: 24.5%, services: 36.9% (in 2023)

Population: **135.47 million**

Religion: **Ethiopian Orthodox Christianity (43.5%), Islam (33.9%), Protestant (18.5%)**

Area: **1,104,300 km²**

Language: **Amharic (official), 80+ local languages, 10% English speaking**

***HDI: Human Development Index**

Adapted from country economy website

ENERGY ASSESSMENT

DOUBLE_SWITCH_

Reliability

**SAIFI = 608 interruptions/customer-year

**SAIDI = 598 hours/customer-year

Affordability

Price: $0.005/kWh (households),
$0.013/kWh (business)

Tariffs ↑ 0.22–0.48 ETB/kWh (2025)

Quality of Energy Services

*T&D Losses: 23.1%

Collection efficiency: 77%

Voltage Fluctuation: ±10–15% in 5.8% homes

Safety

Unclean Cooking: 94% households

Premature Deaths: ~39–68k/yr

Rural Heating/Cooling: 27% access

Environmental impact:

Almost 100% renewables

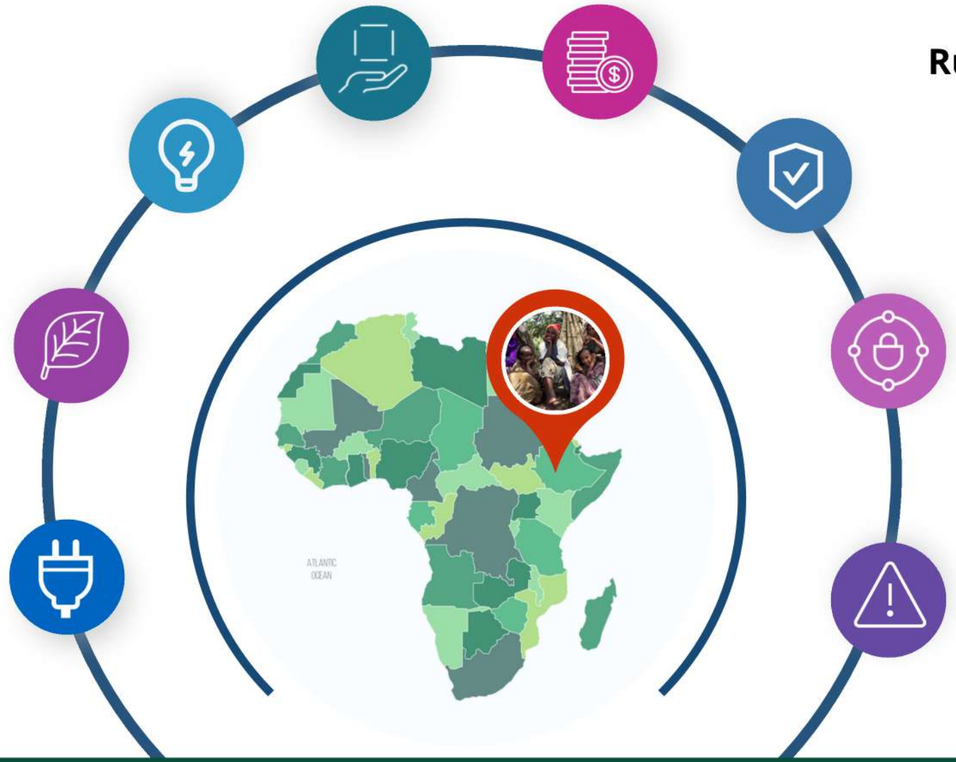
Emissions: 0.13 t CO_2/capita

Fossil Fuels: ~11% of energy use

Security

Non-technical Losses: 11% (theft/errors)

Theft Outages: 24% of cuts



Accessibility

Electrification: 55.4% (Urban 94%, Rural 43.6%)

Clean Cooking: 8.8% (≈95% biomass use)

Potential for roadblocks

Grid limits, hydro reliance, funding gaps, low clean cooking

*T&D: Transmission & Distribution

**SAIFI: NO. of Electricity cuts/year/customer

***SAIDI: No. of hours of power cut/year/customer

Adapted from various references listed in references

ENERGY TIMELINE

DOUBLE_SWITCH_

1956 (11sept)
Ethiopian Electric Light & Power Authority (EELPA) established by Imperial Charter

1960
Koka Dam (43 MW), Addis Ababa's first grid supply

1974
Derg regime nationalizes utilities → rural electrification stagnates

1980
Civil war period → electrification falls to <10%

1996
EELPA reorganized as EEPCo (Ethiopian Electric Power Corporation)

2004
Gilgel Gibe I commissioned

2011
Construction of Grand Ethiopian Renaissance Dam (GERD) launched

2012
Ashegoda (first) wind farm commissioned

2023
$1.7 bn financing secured for grid expansion & renewables

9 September 2025
Inauguration of Grand Ethiopian Renaissance Dam (GERD)

*HDI: Human Development Index

Adapted from various references listed in references

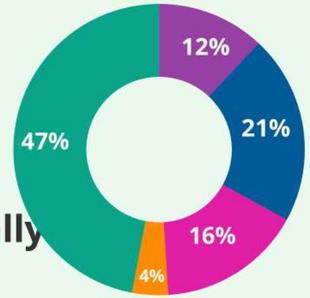
CROSS-BORDER ENERGY

REGIONAL ENERGY ASSESSMENT

DOUBLE_SWITCH_

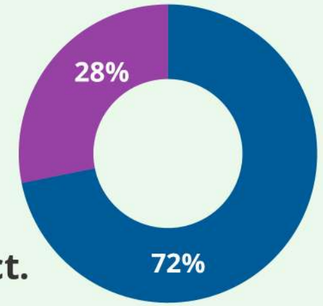
Kenya

- Electrification **76–84% (2023)**
- **16–24%** lack electricity, especially rural. **Grid losses ~20–23%.**



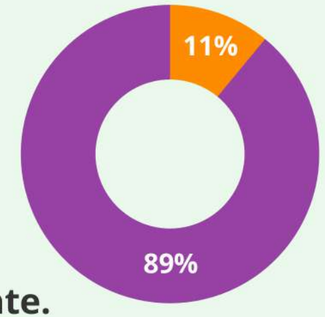
Sudan

- Electrification: **~66% (2023)**
- Grid reliability severely affected by 2023–25 conflict.



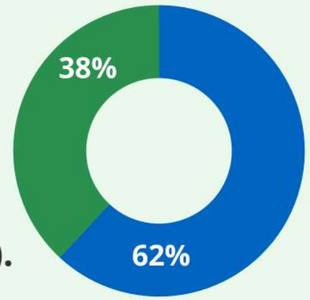
Eritrea

- Electrification: **~48–54%**
- Imported diesel. Almost no large renewable plants; small diesel microgrids dominate.



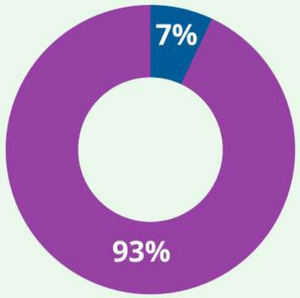
Dijbouti

- Electrification: **~65–70%**, mainly urban
- Tariffs are high (**~$0.22–0.30/kWh**).



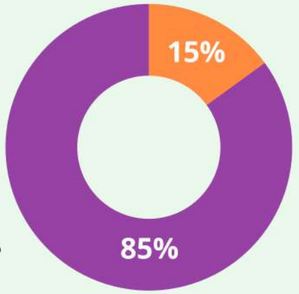
South Sudan

- Electrification : **~5–6% (2023)**
- Relies on **diesel & biomass**; produces **~150,000 bbl/day** crude.



Somalia

- Electrification: **~17–40%**
- Most supply from diesel mini-grids and small solar PVs.



Fossil fuels · Hydro · Solar · Wind · Geothermal

Charts from Excel using data from references

PROSPECTS OF BARTER

DOUBLE_SWITCH_



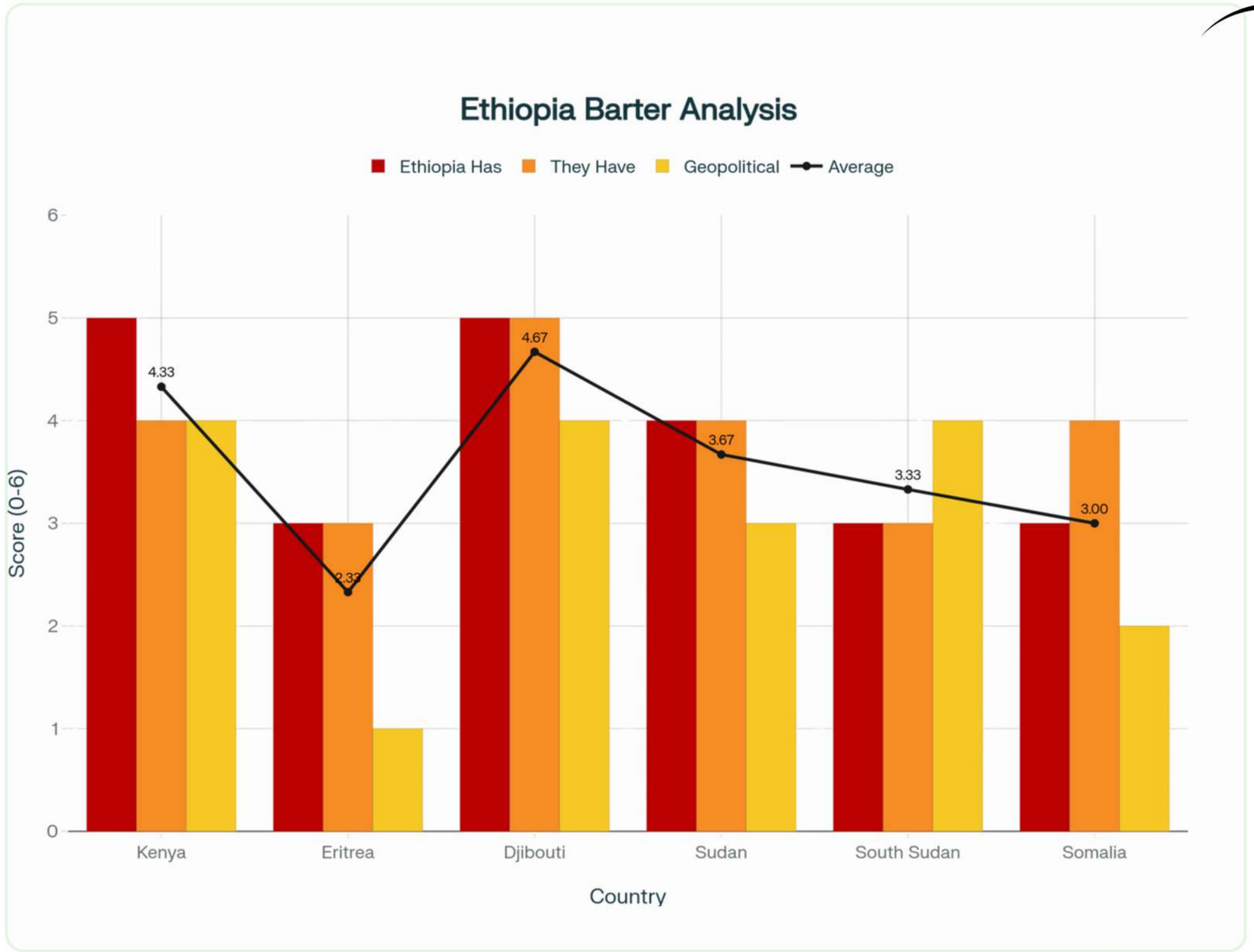



Country	Kenya	Dijbouti	Somalia	South Sudan	Eritrea	Sudan
What They Have for Ethiopia	-Geothermal expertise (Africa's top producer).	-Ports -Logistics hub -Cheap internet	-Ports -High solar & wind potential	-Crude oil supply -Land for regional grid links	-Red Sea ports for trade routes	-Oil -Thermal plants support
What Ethiopia Has for Them	- Hydropower exports -Agro-products	-Cheap clean electricity -Economic Integration	-Hydropower -Grid know-how	-Renewable Energy -Food supply -Trade corridor	-Cheap Hydro -Food supply -Transport	-Oil and gas reserve -Hydroelectricity
Geopolitical relations	-2025 defense pact -2,000 MW power exchange highway -Trade growing	-Key port access - Rejects Ethiopian maritime goals -Egypt alignment	-Rivalry over Red Sea -Turkey mediates diplomatic reset	-Growing infrastructure links -Planned oil routes via Djibouti	-Fragile peace -Sporadic borders -Sensitive local trade	-Trade continues -GERD tensions shift negotiation stance

Adapted from various references listed in references

ENERGY STATE OF ETHIOPIA

BARTER FEASIBILITY CHECK



This graph summarizes Ethiopia's barter potential with neighbors across three key factors.

Assets Ethiopia Offers	Assets They Offer Ethiopia	Current Geopolitical Context

The graph ranks Djibouti, Sudan, and Kenya as top partners, scoring high across all metrics.

Djibouti

- Key port access, Robust logistics
- Clean electricity
- Reliable diplomatic ties.

Sudan

- Valuable oil and gas reserves
- hydro power support
- pragmatic trade relations despite GERD tensions.

Kenya

- Leading geo-thermal expertise
- major power exchange agreements
- expanding trade

The graph identifies Djibouti, Sudan, and Kenya as Ethiopia's top barter partners, offering resource synergy, stability, and mutual economic benefits.

Graph plotted using Heuristic scores

SUSTAINABLE ENERGY RESOURCES

Solar

Expanding via off-grid and utility plants (e.g., Metehara), supports rural electrification and complements hydro. Slowed by import reliance, high battery costs, and weak maintenance capacity.

Hydro

Ethiopia's main electricity source (e.g., GERD), low-carbon and exportable. Vulnerable to drought, costly, long construction, with environmental/resettlement impacts.

Wind

Projects like Ashegoda and Adama diversify the mix and cut emissions. Limited by intermittency, remote sites, and grid integration challenges.

Geothermal

Rift Valley plants (Aluto-Langano, Corbetti, Tulu Moye) provide reliable baseload, independent of seasons. High investment, technical needs, and long development times limit growth.

Nuclear

Offers low-carbon, stable baseload and industrial support. Requires high capital, skilled workforce, safety systems, and waste management.

Biogas

Household/industrial digesters generate clean energy from waste, reduce environmental impacts, and support rural access. Growth constrained by feedstock logistics and upfront costs.

UNSUSTAINABLE ENERGY RESOURCES

Coal

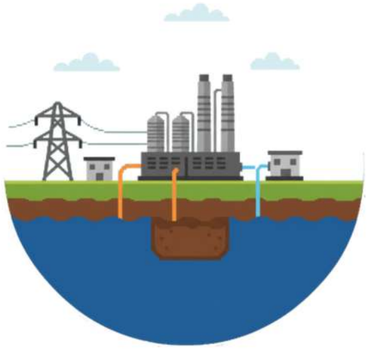
Expanding via off-grid and utility plants (e.g., Metehara), supports rural electrification and complements hydro. Slowed by import reliance, high battery costs, and weak maintenance capacity.

Biomass

Mainly industrial use to replace imports; provides steady energy but causes high pollution and GHG emissions. Expansion limited by environmental and financial constraints.

Oil/Petroleum

Imported fuels dominate transport and backup. Reliable but raises economic vulnerability, pollution, and carbon emissions, Recent hydrocarbon reserves have been discovered though.



Natural Gas

Domestic reserves could serve industry and backup power. Cleaner than coal but still fossil-based, with emissions and infrastructure challenges.

ENERGY STATE OF ETHIOPIA: STATS

DOUBLE_SWITCH_

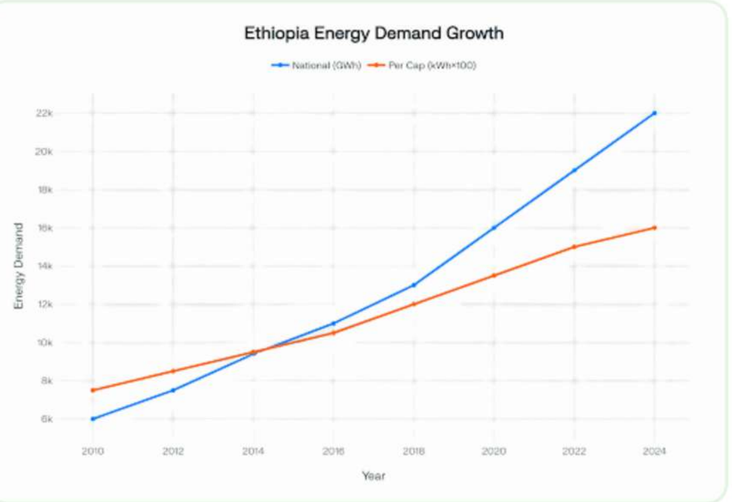
Ethiopia Power Generation by Source, 2025

Technology	Count of Plants	Installed Capacity	Annual Production
Hydropower (incl. GERD)	70	9,800 MW	28.0 TWh
Wind	6	425 MW	1.2 TWh
Solar	10	350 MW	0.6 TWh
Geothermal	1	7 MW	0.02 TWh
Thermal / Diesel Backup	30	120 MW	0.3 TWh

Overdependency on Hydro

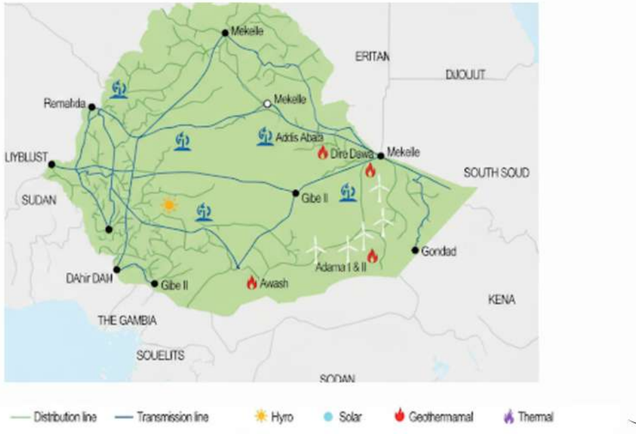
most underutilized Energy Technology

This chart illustrates Ethiopia's rapid energy demand growth from 2018 to 2025, showing that **industrial energy demand has sharply outpaced per capita consumption**. The widening gap highlights accelerated **industrialization as a key driver** of total national energy needs, outstripping growth in average individual usage.



National energy demand has tripled in 14 years, showing **fast industrial growth** and improving living standards.

ELECTRICITY INFRASTRUCTURE AND POWER PLANTS IN ETHIOPIA



Ethiopia's electricity infrastructure connects major cities and relies mostly on hydropower, but **large rural areas still lack reliable grid access**. The country is expanding renewables and cross-border transmission to boost energy supply and export capacity.

Energy trade split

Exports 70%

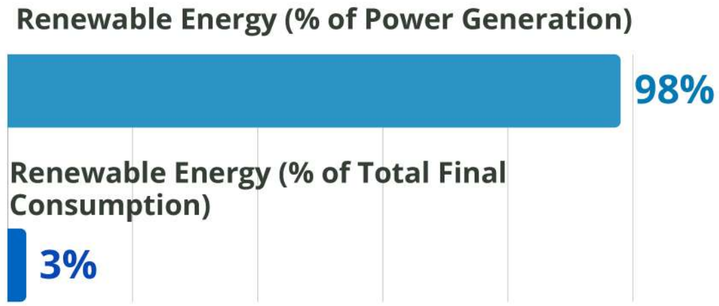
Imports 30%

African Energy, World Bank, IEA

ENERGY STATE OF ETHIOPIA: STATS

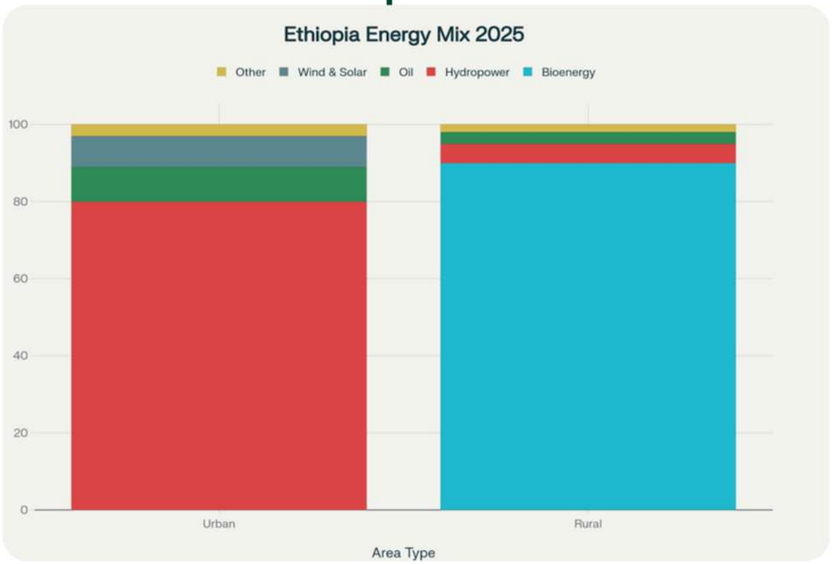
Access to Electricity(%) [2024]

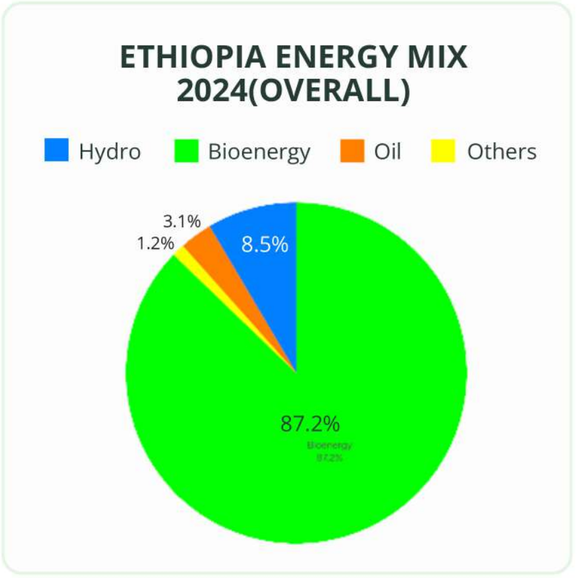
Access to Clean Cooking(%) [2024]



Urban areas largely access clean, renewable grid electricity, while **rural communities rely on traditional biomass,** highlighting the need for expanded rural electrification and off-grid renewables.

Installed Power Generation Capacity	**5,200 MW**
Peak Electricity Demand	**2,288 MW (Oct 2024)**
Renewable Capacity per Capita	**42 (Watts)**
International Financial Flows (USD million, 2023)	**300**





CURRENT SCENARIO V/S VISION 2035

Overdependence On Hydro

Current Status

90.6% of generation from hydropower; highly **vulnerable to droughts and variability**.

Vision 2035

Hydro share reduced below **75%** through **diversification** into **wind, solar, and geothermal (~25%)**

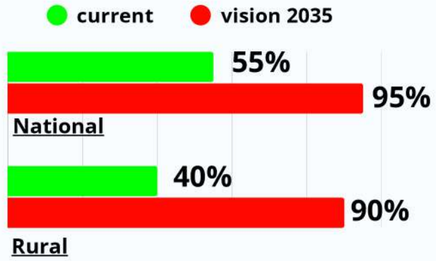
Electricity Provision Capacity

Current Status

National access **55%**, with rural access under **40%**

Vision 2035

Universal access **95%**, reaching **10M grid and 9M off-grid** households



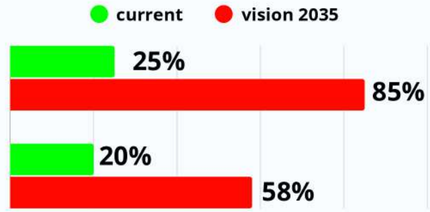
Access To Electricity

Current Status

Limited grid reliability, high transmission losses, and low rural connectivit

Vision 2035

Strengthened grid infrastructure (**58% investment share**) **ensures nationwide reliability and resilience**



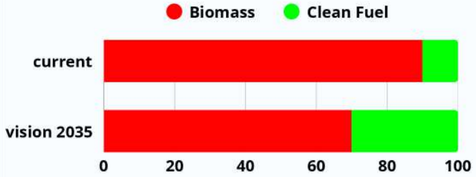
Cooking Fuels

Current Status

Over **90%** of households rely on biomass (wood, charcoal)

Vision 2035

Over **70%** households adopt clean fuels—**LPG** in urban, improved biomass stoves in rural areas



ISSUE ANALYSIS

OVERALL ENERGY PROBLEMS

Overdependence On Hydro

- Heavy hydro reliance causes **drought-season shortages.**
- **Uneven hydro spread** limits regional reliability.
- **Lack of diversification** heightens climate risk.
- **Few major plants** threaten supply stability.
- Geopolitical conflict over shared river - Nile

Electricity Provision Capacity

- **High electricity losses** occur during transmission.
- **Financial limits and weak institutions** hinder progress.
- **Lack of data** affects grid and off-grid performance.
- **Poor interconnections** between energy-rich and poor areas.

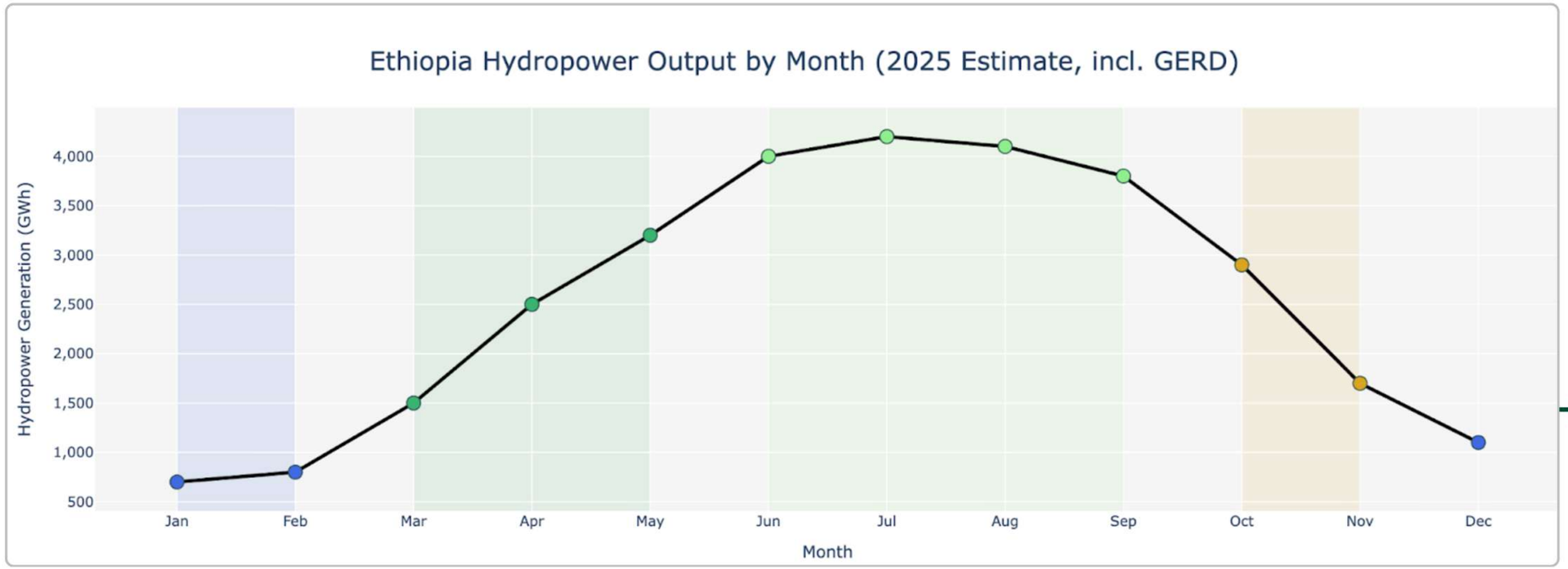
Access To Electricity

- Reliable electricity remains **unaffordable for many.**
- Rural electrification levels are **still low.**
- **Supply shortages** and **high prices** persist.
- Many households avoid paying for **stable power.**

Cooking Fuels

- Clean cooking adoption **remains low.**
- Biomass use drives **deforestation** and **indoor pollution.**
- Women face added **health** and **time burdens.**
- Modern fuels remain **costly** for most families.

OVERDEPENDENCE ON HYDRO



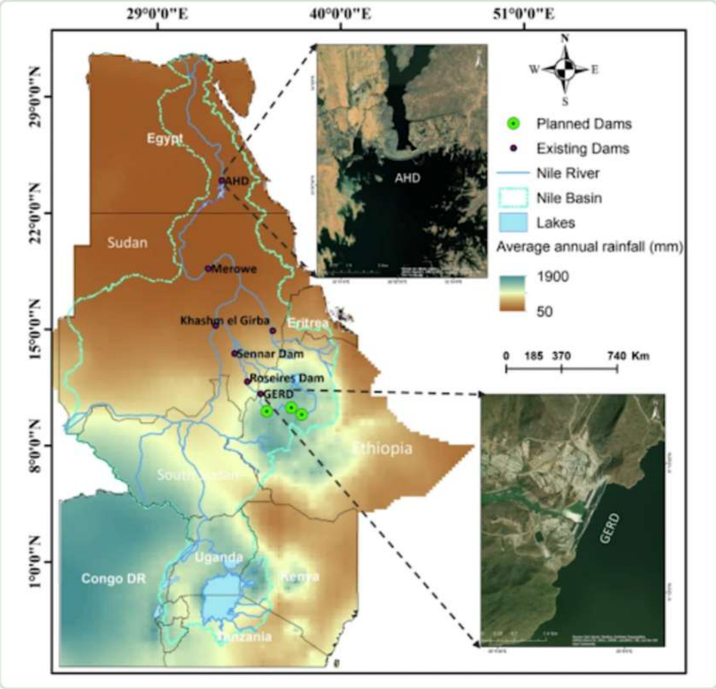
Ethiopia's estimated 2025 hydropower generation is highly seasonal, peaking at over 4,000 GWh in the summer. This trend directly corresponds with the country's rainy season, which fills the reservoirs of major dams like the GERD and boosts electricity production.

- **Ethiopia’s electricity system relies on hydropower (~90.6%), making it highly vulnerable to drought and climate variability, which threatens energy security, industry, and economic stability.**
- **A 5% rainfall decline can cause a 10% drop in agricultural output and significant hydropower losses. While GERD boosts capacity, it also concentrates risk within the same climatic basin.**

Geographic & Climatic Vulnerability: Most hydropower resources are concentrated in a few river basins, especially the Blue Nile (85% of Nile’s downstream water).

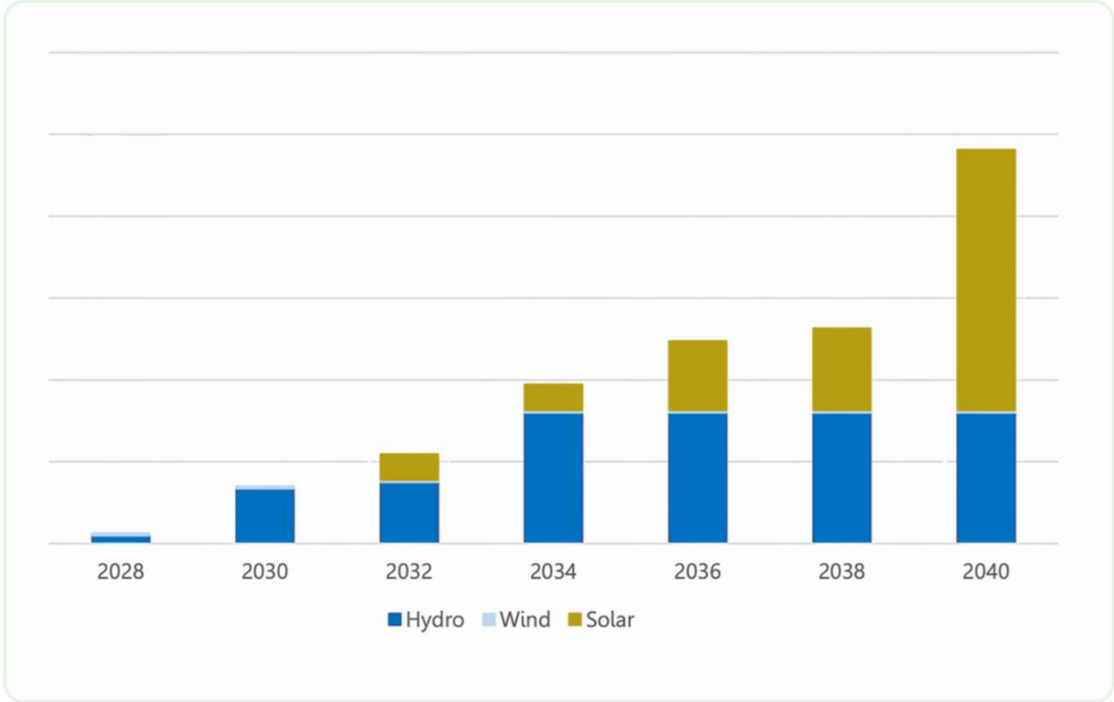
Adapted from various references listed in references for the data and hence curve is ploatted

OVERDEPENDENCE ON HYDRO



(nature magazine)

- **Geopolitical Vulnerability:** Shared use of the Blue Nile with Sudan and Egypt fuels tensions over GERD operations due to downstream flow concerns.
- These conflicts could result in operational restrictions, delayed projects, and increased transboundary water risks, making Ethiopia's hydropower strategically fragile.



(policy, Ethiopia Energy Outlook 2025)

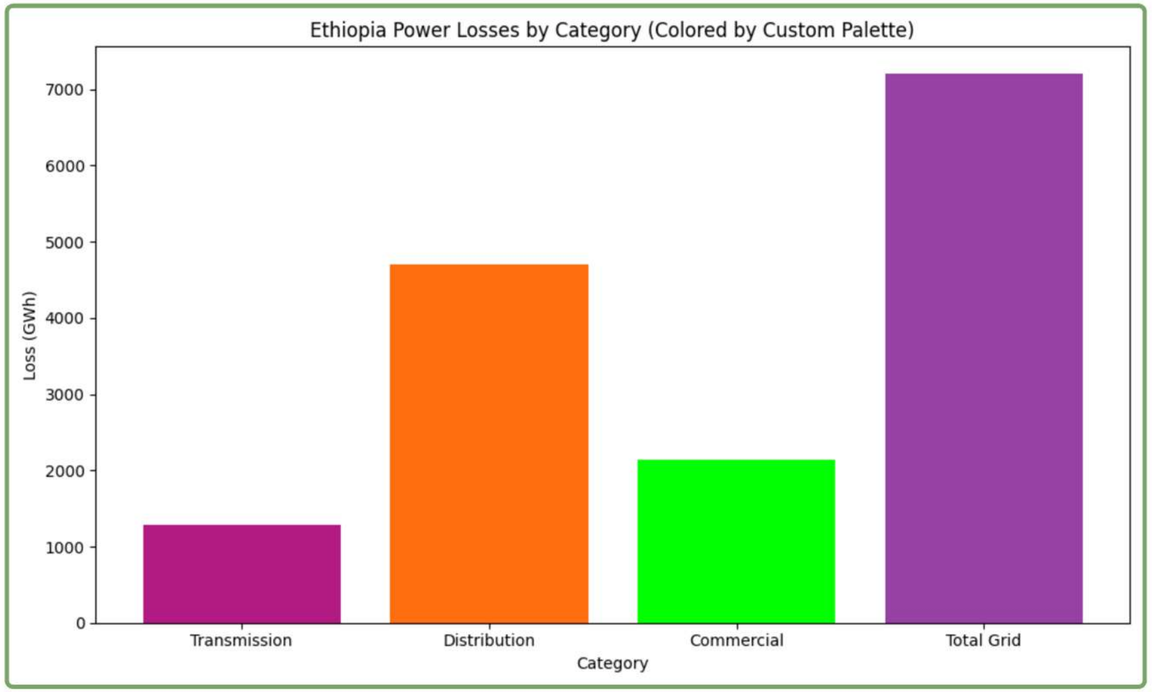
Ethiopia possesses massive untapped renewable resources:

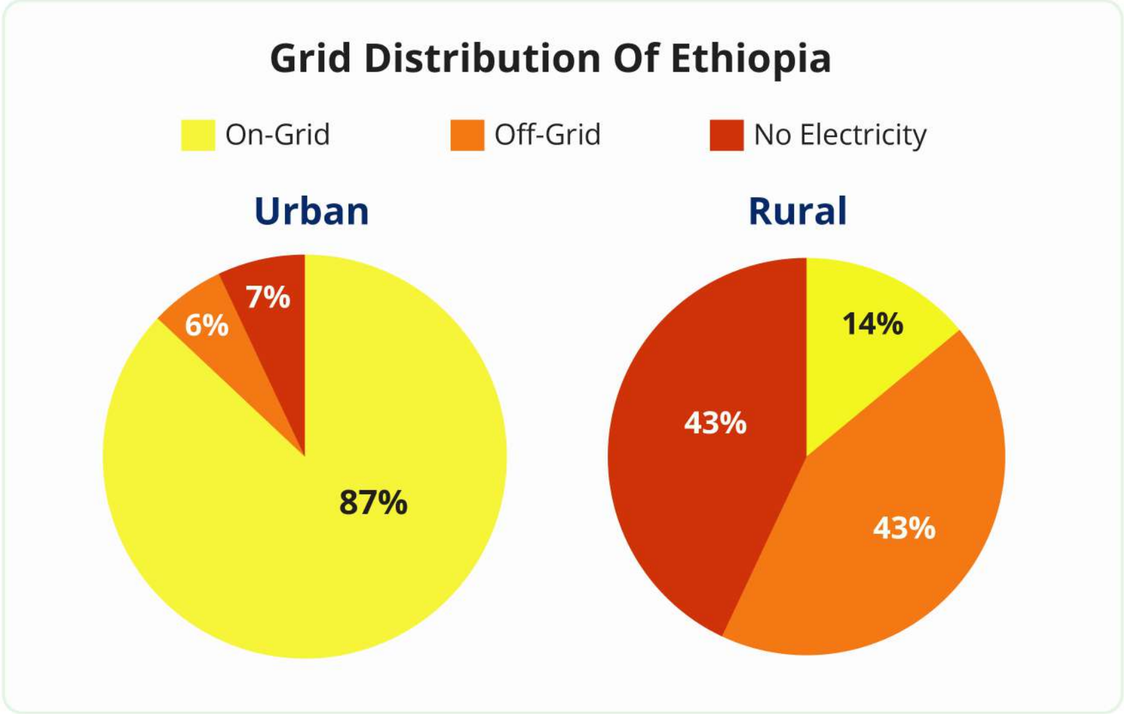
- **Wind:** 100,000+ MW potential, 700 MW developed
- **Solar:** 50,000+ MW potential (5.2–6.5 kWh/m²/day), 700 MW developed
- **Geothermal:** 10,000 MW potential, 700 MW operation

Adapted from various references listed in references for data to plot the graph

ELECTRICITY PROVISION CAPACITY

- **Ethiopia's ageing grid loses 18.5–23% (up to 40%) of power annually — 3,960–7,200 GWh wasted — due to poorly maintained lines causing about 42 outages weekly in Addis Ababa.**





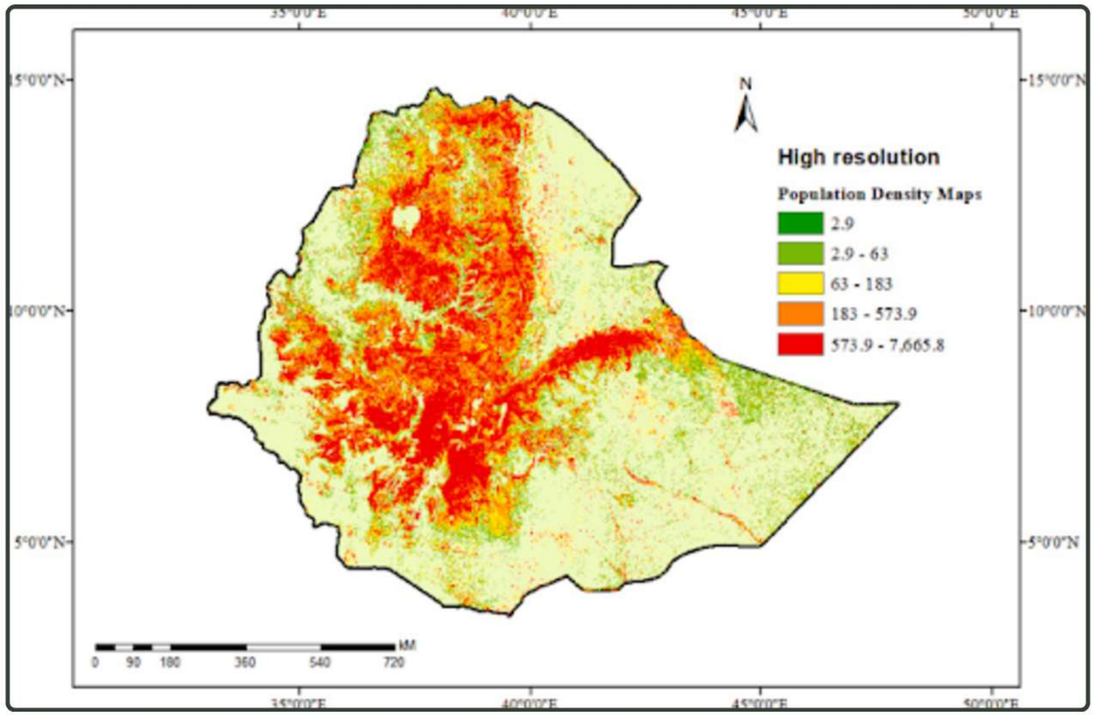
- **Grid modernization requires $1.4 B/year, but revenue covers only 71% of costs. Achieving universal access needs a +47% transmission expansion (20,390→30,000 km), +155% distribution growth (179,000→456,000 km), and new substations.**

Adapted from various references listed in references

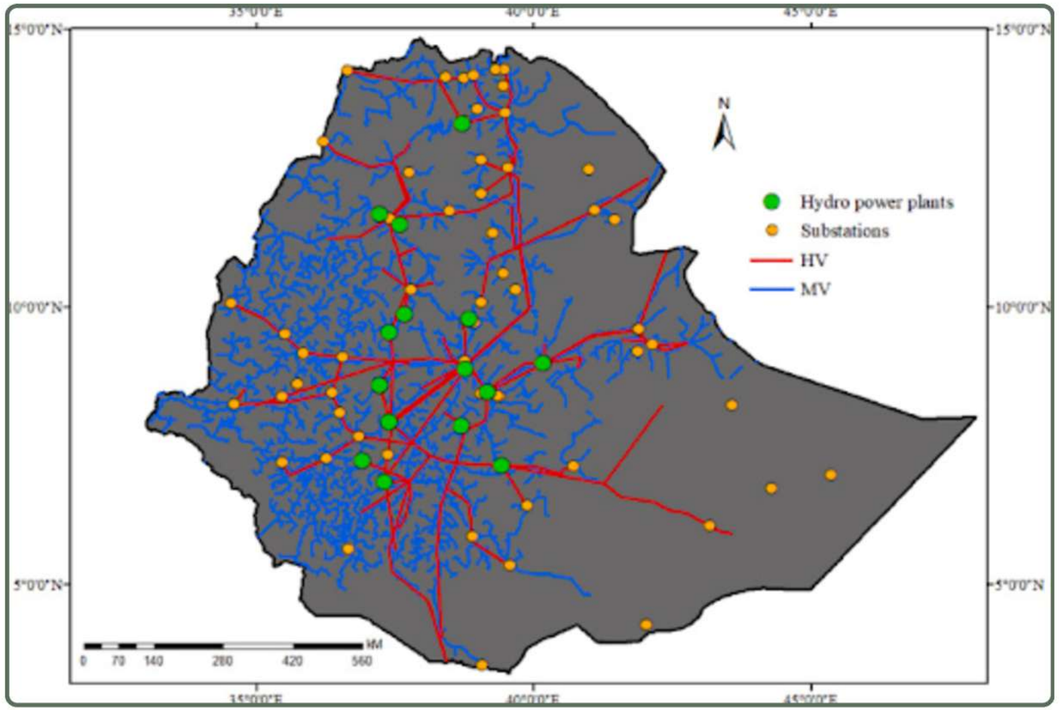
ELECTRICITY PROVISION CAPACITY

DOUBLE_SWITCH_

Popular Density Of Ethiopia



Ethiopia Power Infrastructure



- **Ethiopia's electrical grid suffers from catastrophic losses (18.5-40% of generation), frequent blackouts, and aging infrastructure unable to support economic development or service delivery.**
- **Reliability is dire (SAIDI 597 hrs/year, SAIFI above limits); 88% of blackouts stem from utility failures, with losses of 6% in transmission, 22% in distribution, and 10% commercial (~2.7 M Birr theft per quarter).**

Adapted from various references listed in references

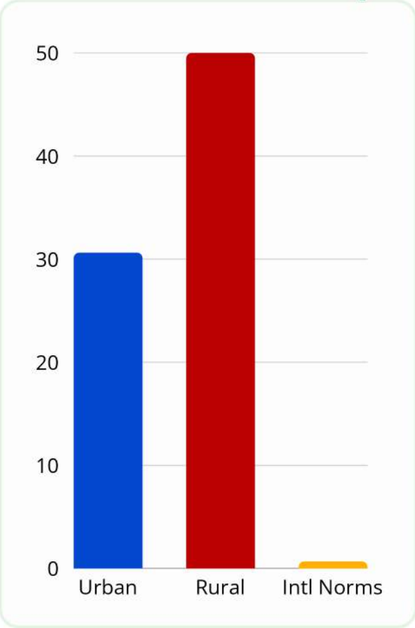
ACCESS TO ELECTRICITY

Electricity access

Urban 92.8%

Rural 36.3%

Unreliability



Urban areas face **30.6 outage hours monthly** and rural households endure **50 hours monthly**, which is extremely more than international norms.

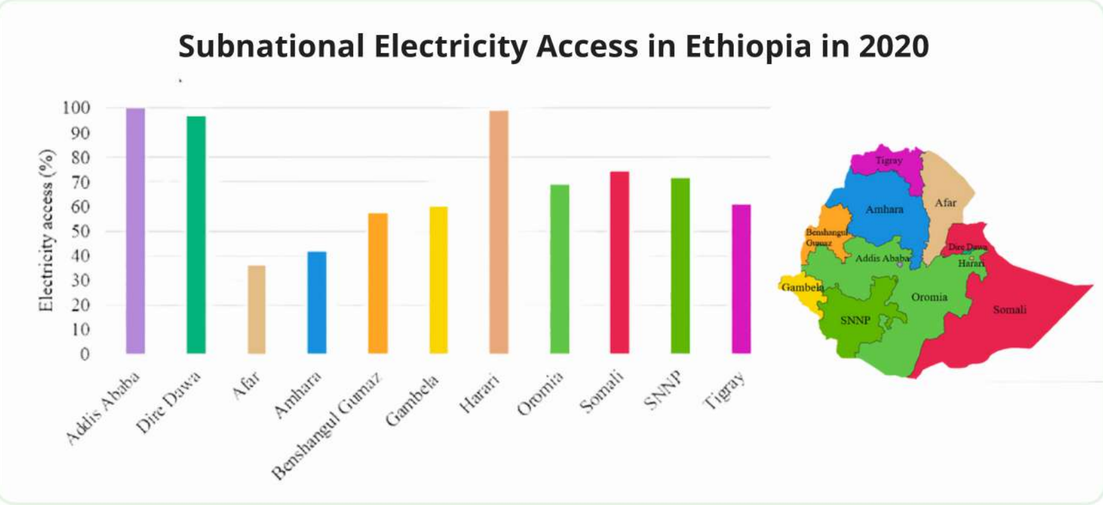
Even grid-connected households experience:

- 58% of grid-connected homes face 4–14 outages weekly, and 3% suffer over 14.
- Average blackout duration is about 46 hours.

Unaffordability

connection fees($75) > Average rural income($58/month)

- make legal electricity access unaffordable for most rural households.

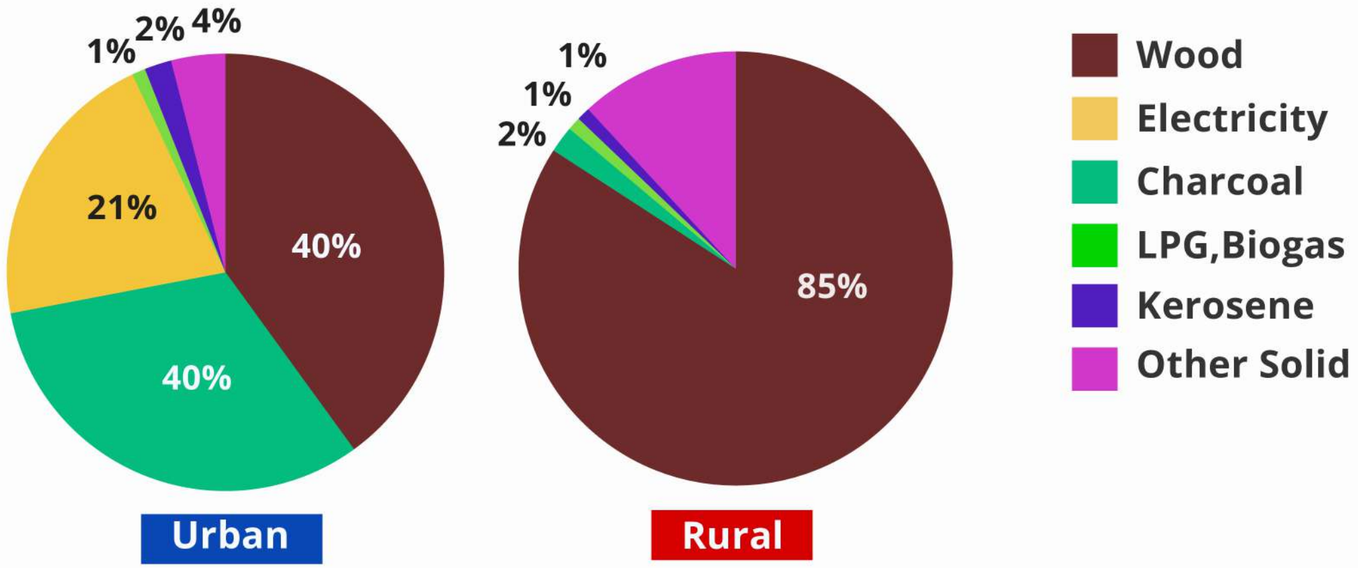


Ethiopia's electricity rollout favors urban, high-density areas, leaving low-density peripheral regions largely underserved due to high costs and logistical challenges.

Adapted from various references listed in references

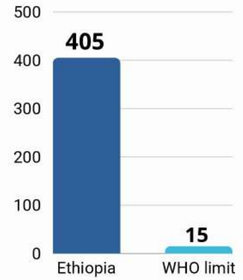
COOKING FUEL CRISIS

Cooking fuel distribution



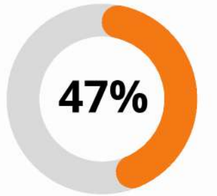
- **Using 116 million m^3 of wood for cooking** causes deforestation and emits CO_2 and black carbon, intensifying climate change.
- **Women spend 2–4 hours daily collecting fuel**, leading to major opportunity costs, health risks, and reinforcing gender inequality.

Health Impact



PM2.5 average levels of 405 µg/m^3 - 16-24 times higher than WHO safe limits of 15 µg/m^3.

60% of women who cook experience respiratory symptoms.



Anemia correlation: Biomass users have 47% higher mild anemia risk

IEA, World Bank, IMF Data

SOLUTION:

1.ON GRID SOLUTION

ON GRID CHALLENGES & FIXES

GRID PROBLEMS	PROBLEM DESCRIPTION	SOLUTIONS
Transmission Loss (6% Loss)	Loss of ETB 1.66 B/year	Strengthen 9,000 km of transmission lines and install high-capacity conductors.
Distribution Loss (22% Current Loss)	Loss of ETB 6.116 B/year	Upgrade 40,000 km of distribution lines (33 kV/11 kV/400 V) and replace old transformers.
Commercial Loss (Theft) (10% Loss)	Loss of ETB 2.78 B/year	Deploy 5.9 million smart electricity meters across all grid households
Substation Overloading (39 Substations)	Too few(39) substations lead to 10 minutes of outages annually.	Construct and upgrade 200 substations with automation
System Reliability/Loss (38% Loss, 10 min Outage)	System inefficiency forces extra power generation of ~6,000 GWh to offset losses.	SCADA and AMI systems and train 6,000+ staff to achieve a 18% system loss target

SCADA: Supervisory Control and Data Acquisition, AMI: Advanced Metering Infrastructure

ON GRID SOLUTION: ACTION PLAN AND IMPACT

IMPLEMENTATION: ACTION PLAN

01 Pilot Setup

Launch pilot for 5% population in Addis Ababa, finalize design, financing, and governance.

02 Urban Upgrades

Modernize six major cities with SCADA, smart meters, and substations.

03 Peri-Urban Expansion

Extend upgrades to outskirts with AMI, MDMS, and added substations.

04 City–Suburb Links

Upgrade feeders to connect suburbs and nearby towns, improving stability.

05 Rural Rollout

Expand access to rural areas with network upgrades and smart metering.

06 System Integration

Unify systems under national SCADA, train staff, and reduce losses to 18%.

Annual Electric Sales Revenue

$300M 2025 → $420M 2035

Annual Revenue Lost to Losses

$190M 2025 → $75M 2035

Annual Generation Required

16TWh 2025 → 10TWh 2035

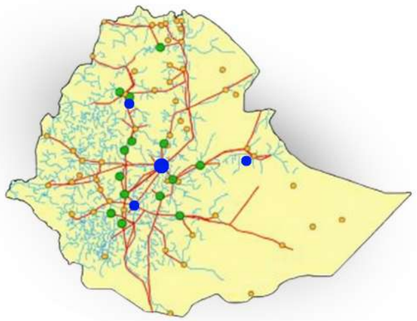
Annual Customer Outage

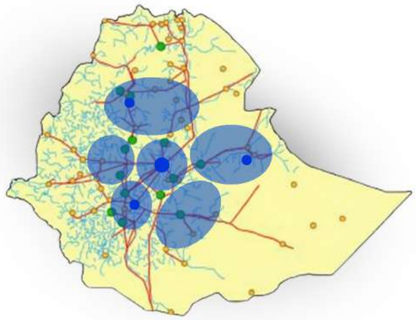
10min 2025 → <1min

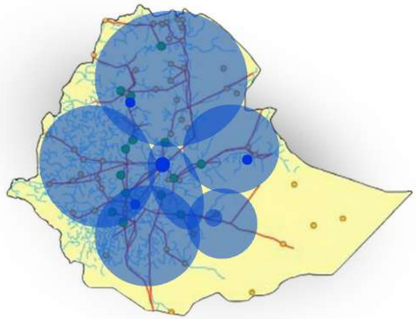
MDMS: Meter Data Management System

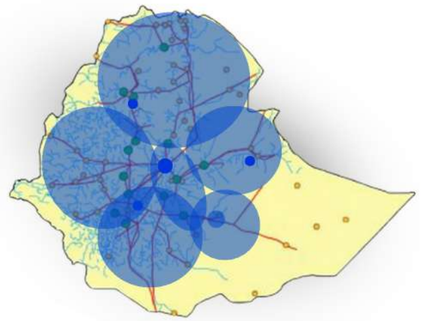
Refereces taken from NEP 2.0 implementation plan

ON GRID SOLUTION: IMPLEMENTATION PLAN









01

Foundation & Pilot

(2026-2027)

Cities & Zones:
All major cities: Addis Ababa, Bahir Dar, Hawassa, A → Core city centers

Network Upgrades:
50 km → 6 000 km total

Meters Deployed:
1 210 000 total (10 000 + 1 200 000)

Substations Added/Upgraded:
31 total (1 pilot + 30 new)

Key Milestones:
Pilot success; governance in place; 20% urban meters installed; SCADA live

02

Urban Expansion

(2028-2029)

Cities & Zones:
City peripheries → Secondary urban corridors

Network Upgrades:
9 000 km → 12 000 km total

Meters Deployed:
1 980 000 total (1 080 000 + 900 000)

Substations Added/Upgraded:
42 new total (24 + 18)

Key Milestone:
40% urban coverage; AMI operational; 60% urban household coverage

03

Rural Integration

(2030-2031)

Cities & Zones:
Outer radial zones → Grid-adjacent rural areas

Network Upgrades:
15 000 km → 18 000 km total

Meters Deployed:
1 320 000 total (720 000 + 600 000)

Substations Added/Upgraded:
18 new total (12 + 6)

Key Milestone:
75% urban + peri-urban coverage; 90% of city-adjacent households served

04

Completion & Optimization

(2032-2033)

Cities & Zones:
Outer radial zones → Grid-adjacent rural areas

Network Upgrades:
21 000 km → Complete

Meters Deployed:
780 000 total (480 000 + 300 000)

Substations Added/Upgraded:
24 upgrades (existing)

Key Milestone:
100% grid-connected households served; 18% system losses achieved; Project complete

Refereces taken from “Eastern Ethiopia Electricity Grid Reinforcement Project – Final Report,” Ethiopian Electric Power, AFDB, & Korean Exim Bank, March 2024.

ON GRID SOLUTION: BARTER INTEGRATION

DOUBLE_SWITCH_

Barter: Diesel supply from Sudan in exchange for future renewable electricity or infrastructure services

Diesel Bartered for Each Phases

01	02	03	04
64 M liters ($51M)	167 M liters ($134M)	23 M liters ($91M)	8 M liters ($6M)
2026-2027	2028-2029	2030-2031	2032-2033

"Total diesel required for reliable power: 263 million liters valued at $210M to keep cities running during wiring and upgrades."

Calculation: MW × hours × 0.26L/kWh

RSF: Rapid Support Forces

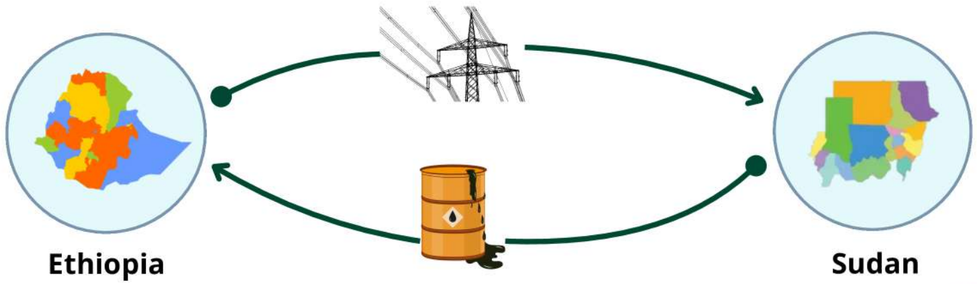
Mutual Benefits

Ethiopia

- Power continuity during rewiring and upgrades.
- Urban and industrial hubs can't afford outages.
- Diesel can be deployed quickly, works in any climate, and is logistically straightforward

Sudan

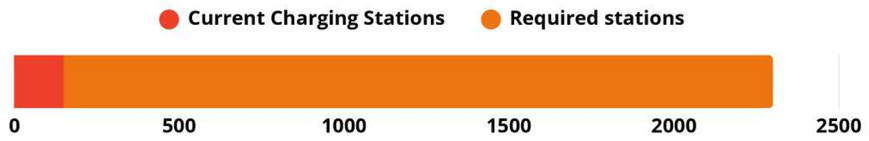
- RSF drone strikes shattered Sudan's power plants and grid in 2025.
- Ethiopia's renewable electricity remains stable and export-ready.
- Diesel-for-power trade would quickly restore Sudan's energy access.

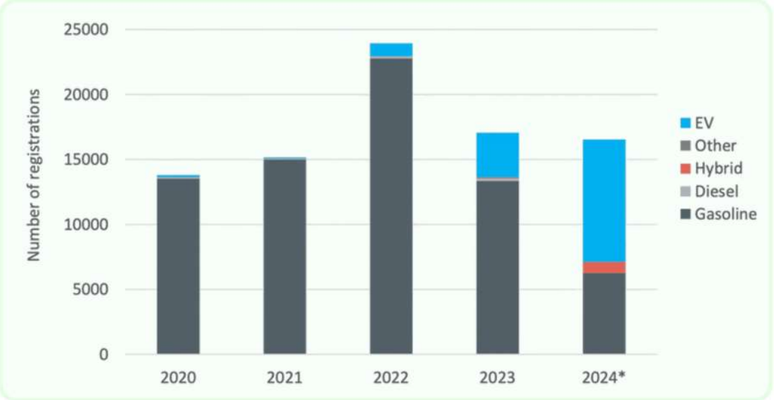


Etichia, M. "Energy trade tempers Nile water conflict," Nature, 2024

ON GRID TRANSPORT

Project Overview





(policy, Ethiopia Energy Outlook 2025)

Development Scope

- **6,000 charging stations** across Ethiopia over 2 years (2026-2027
- Support 100,000+ electric vehicles (1 charger per 17 EVs)
- Total Investment: $237.4M USD over 2 years
- Grid Power Requirement: 274.5 MW peak capacity

DEPLOYMENT TIMELINE

Rapid Infrastructure Rollout

✓ Install 3,000 chargers/year (250 stations/month)
✓ Focus on Addis Ababa, regional capitals, highway corridors
✓ Parallel grid stability improvements

Operations During Grid Modernization

✓ 10-year operational period aligned with national grid improvement plan
✓ Charging network operates as grid achieves stability
✓ Annual operating cost: $27M USD

Project Outcome

100,000+ EVs operating nationwide

274.5 MW clean transport energy demand

$500M+ fuel import savings over 10 years

SOLUTION:

2(A).OFF GRID SOLUTION

OFF GRID SOLUTION: SOLAR HOME SYSTEMS (SHS) ROLLOUT

DOUBLE_SWITCH_

Total Energy Generation

1,656 GWh/year
(2035)

Household SHS:
1,476 GWh

Agricultural Irrigation:
180 GWh

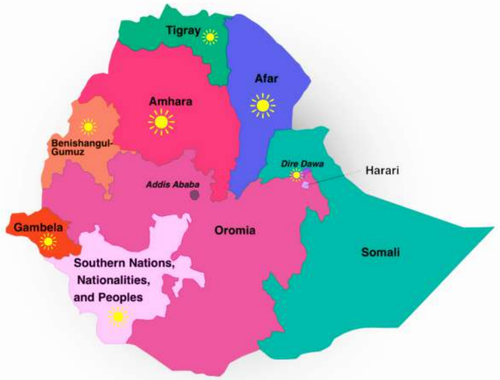
(SHS) – Ethiopian Potential

5.5 kWh/m²/day solar resource ensures consistent generation.

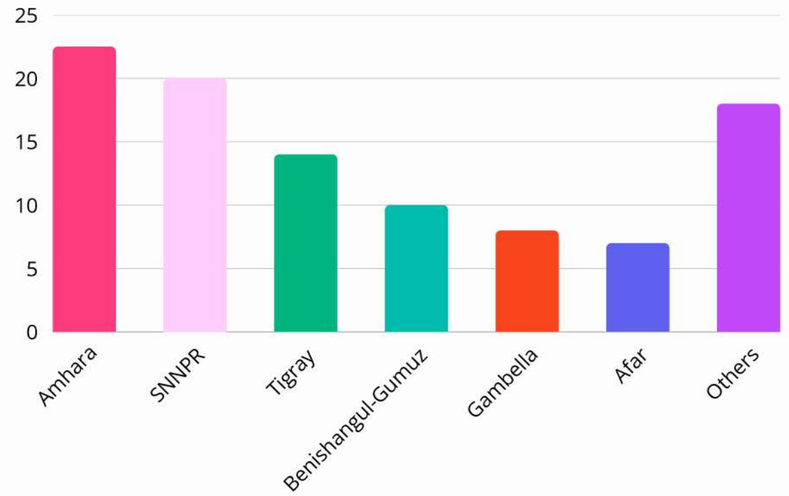
Replaces **USD 95 M/year** kerosene and diesel use.

Proven adoption - **1.5 M+ SHS units** already deployed.

SHS Deployment per province (%)



Areas of deploying SHS



Willingness to Pay

Considering 6 hours of daily use, then monthly cost for

With SHS

Monthly Cost- $4.5
Upfront - $8
Monthly Instalment- $3

Total monthly cost - $7.5

which is less than monthly cost without SHS $9
so,

cost of (SHS) < (battery/charging/kerosene)

Target Population

9.2 million households
46 million people

SOLAR HOME SYSTEMS (SHS) ROLLOUT: IMPLEMENTATION PLAN

DOUBLE_SWITCH_

PILOT & AWARENESS

Locations:
Amhara, SNNPR, Benishangul-Gumuz (highest off-grid need)

Pricing:
PAYG—USD 5 down payment, USD 2/month for 20 months

Awareness:
"Bright Homes, Better Lives" campaign: Community radio + solar demo nights to show real savings and reliability.

3 million SHS (serving ~15 million people)

Solar pumps irrigating 250,000 hectares (separate from SHS).

(2026 -2028)

(2029 -2031)

ADOPTION & SCALE

Locations:
Oromia (non-grid areas), Tigray, Gambella, Afar; expansion into remaining woredas

Pricing:
PAYG—USD 8 down, USD 3/month for 18 months

Adoption:
Youth Solar Champions Program: Train local students as door-to-door energy advocates and mobile-payment guides.

cumulative 8 million SHS (~40 million people)

Solar irrigation for 900,000 hectares, emphasizing cluster farming.

FULL MARKET & SUSTAINABILITY

Locations:
Coverage of all rural/off-grid communities in Ethiopia

Pricing:
PAYG—USD 10 down, USD 3–4/month for 18 months, phased subsidy removal

Support:
Women Power Circles: Partner with women co-ops to host market-day solar booths for lighting and irrigation awareness.

9.2 million SHS households (~46 million people)

1.05 million hectares under solar irrigation

(2032 -2035)

PAYG: Pay-As-You-Go

SOLUTION:

2(B).OFF GRID SOLUTION & DIVERSIFICATION OF ENERGY

OFF GRID SOLUTION: WIND INTEGRATION

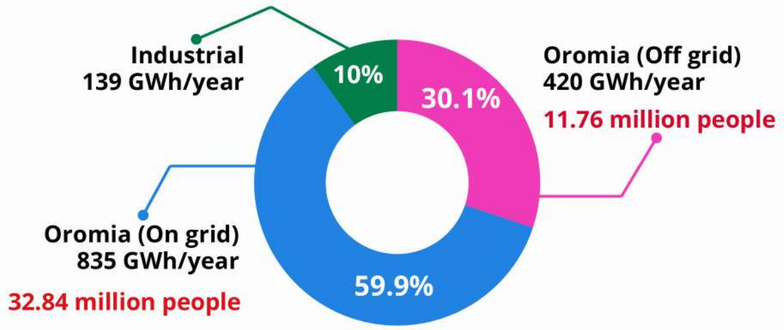
OROMIA WIND INTEGRATION

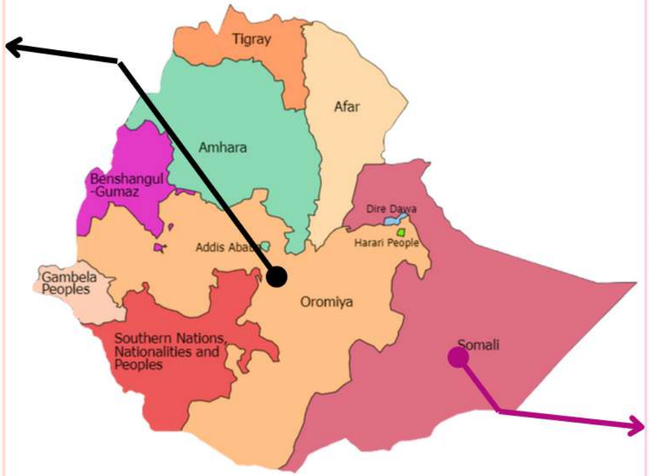
PROJECT HIGHLIGHTS

- Assela I (100 MW) active; Assela II (150 MW) and Adama (204 MW) advancing clean power expansion.
- Total capacity: 454 MW (1391.7 GWh/year)
- Supplies Adama and Bishoftu parks, powering textile, agro, pharma, cement, and auto industries.

GRID & STORAGE

- 150 km 230 kV transmission upgrades
- 150 MW / 600 MWh BESS for grid stability
  Substation reinforcement ongoing





BESS: Battery Energy Storage System
SCADA: Supervisory Control and Data Acquisition

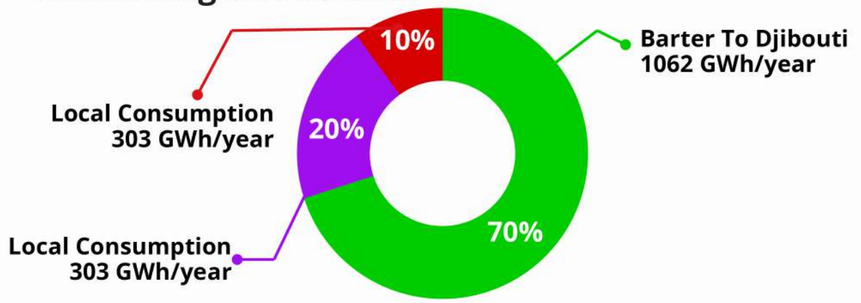
SOMALI WIND INTEGRATION

PROJECT HIGHLIGHTS

- 392 MW total capacity | 1517 GWh/year generation (2035)
- Full national grid integration
- Phase 3 yet to be done adds 583 GWh/year
- Serves: agro-processing, mining, construction, trade logistics
- Barter wind energy with Djibouti (70%) in exchange of port access and reduced port charges on imports
- Barter with Kenya for securing the Somali wind farm in exchange of surplus agro-products

GRID & STORAGE

- 230 kV, 100 km line with 100 MW/400 MWh BESS nearing completion for grid stability.
- Integrated SCADA and export metering enhance monitoring and control.



WIND INTEGRATION: IMPLEMENTATION PLAN

Implementation Plan: Somali region

(2026–27) — Launch & Civil Works

EPC signed 230 kV line
50% Civil & foundation start
⚡ 280–306 GWh
👥 2.5 M
🏭 Industrial:71.7 GWh

(2028–29) — Construction & Network

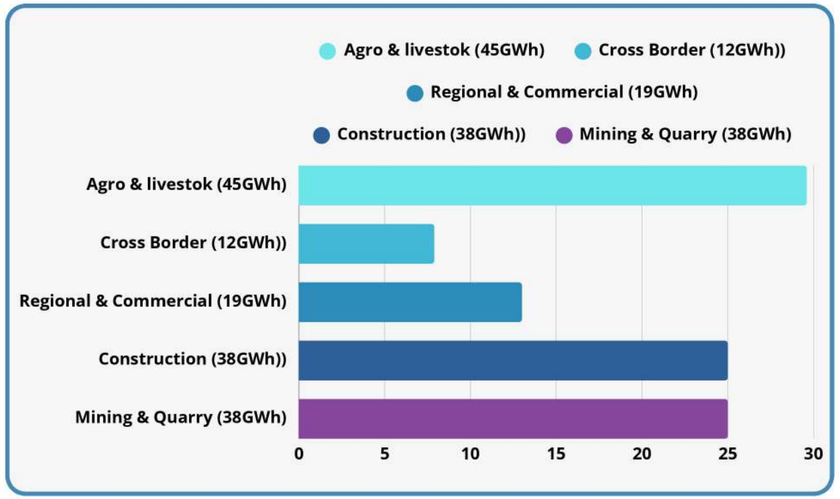
Turbines 100%, Grid 80%, BESS procured
⚡ ~1.2 TWh
👥 4.4 M
🏭 Industrial: 597 GWh

(2030–31) — Grid Integration

Djibouti export link, SCADA testing
⚡ 1.43 TWh
🌍 >800 GWh export

(2032–35) — Full Ops & Stabilization

SCADA active, O&M teams ready, Grid balancing
⚡ 1.52 TWh
👥 5.9 M
🏭 Industrial: 931 GWh



Implementation Plan: Oromia region

(2026–27) — Mobilization

Assela I (100 MW) done; Assela II design + 230 kV survey
⚡ 417 GWh
👥 3.7 M
🏭 Industrial: 78.9 GWh

(2028–29) — Construction

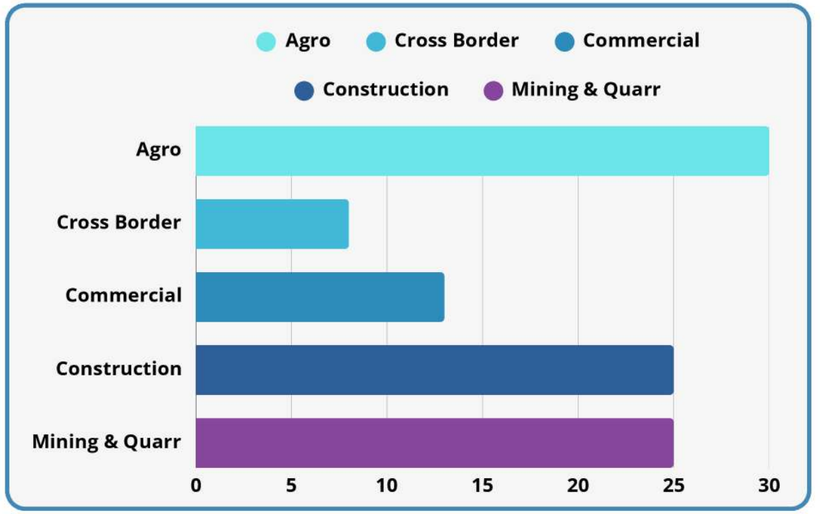
Assela II 40 %, Grid 80%, Dist. 40 %, BESS design
⚡ 0.8–1.1 TWh
👥 8.3 M
🏭 Industrial: 131 GWh

(2030–2032) — Commission & Reinforce

Assela II 95 %, 600 MWh BESS, Dist. 95 %
⚡ 1.2 TWh
🏭 Full industrial load

(2033–35) — Grid Optimization

SCADA + AI maintenance, Training done
⚡ 1.39 TWh
👥 12.3 M (rural coverage)



O&M: Operations & Management, BESS: Battery Energy Storage System , SCADA: Supervisory Control and Data Acquisition, AI: Artificial Intelligence

Danish Ministry of Foreign Affairs. (2019).

SOLUTION:

2(C).DIVERSIFICATION OF ENERGY

GEOTHERMAL ENERGY TAPPING

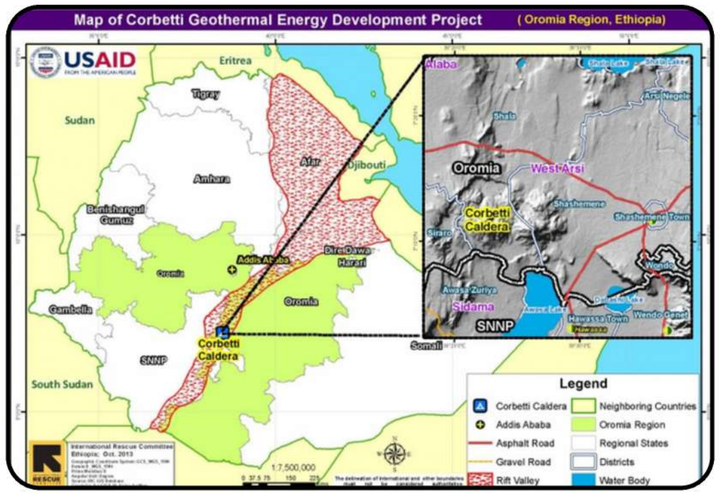
Geothermal Potential

01 ~10 GW potential, only 120 MW utilized.

02 Supports industrial load & grid stability, powering 15–20 M people

03 Can add 7–10 TWh/year firm power by 2035.

04 >90% capacity factor—reliable baseload, unlike hydro.



PPA: Power Purchase Agreement

Project highlights

- Meets geothermal, environmental, and PPA standards for sustainability.
- Ensures stable power, rural jobs, less hydro/fossil use, and stronger renewable exports.
- Provides 24/7 clean baseload power, boosting industry, stabilizing the grid, and supporting rural jobs with low emissions

Implentation Plan

01 (2025–27) — **Exploration & Drilling**

Test wells (Corbetti, Tulu Moye), Grid permits start

⚡ <1 TWh
👥 3.4 M
🏭 213 GWh

02 (2028–29) — **Construction**

Build 150 MW, Transmission live, Partial grid feed

⚡ 1.3–1.8 TWh
👥 8.3 M
🏭 638 GWh

03 (2030–32) — **Expansion**

Start Phase 2 (150 MW), Grid & substations upgrade

⚡ 3–4 TWh stable
👥 15 M beneficiaries

04 (2033–35) — **Optimization & Full Ops**

SCADA + monitoring live, Export ready, 600 MW online

⚡ 7–10 TWh
🏭 1.13 TWh industry
🌆 Reliable urban baseload

World Bank. (2024). Ethiopia Geothermal Sector Development Project, United Nations University Geothermal Training Programme (UNU-GTP), Ethiopia. (2018)

SOLUTION:
3A.COOKING FUEL: RURAL

FUEL TYPE ANALYSIS

Fuel Type	Availability in Rural Ethiopia	Typical Cost	Infrastructure Needed	Climate / Emissions	Suitability for Next 10 Years
 Firewood & Woody Biomass	dominant rural fuel; (90% of total fuel)	Usually self-collected	None beyond collection & storage.	High indoor pollution; improved stoves cut emissions.	Best short–medium term; compatible locally.
 Crop Residues / Dung	Seasonal; fallback when wood scarce.	No cash cost but low energy density.	None; requires drying & storage.	Burning dung removes soil nutrients.	Complementary only — not primary option.
 Kerosene / LPG	Scarce in rural zones; costly refills.	High recurring cash cost.	Supply chains + storage cylinders.	Cleaner than biomass but fossil-based.	Low suitability — unrealistic at scale without subsidies.
 Electricity / Electric Injera Stoves	Limited rural grid access.	Very high up-front appliance cost.	Grid connection + reliable power.	Zero end-use emissions (if hydro).	Long-term goal, not viable for most rural households < 10 yrs.
 Biogas (Micro-digesters)	Viable where livestock available.	Moderate capital cost.	Requires digester, training & maintenance.	Low GHG + clean cooking.	Niche use — household-level only.

Biomass will remain dominant; improved stoves (Gonzie / Mirt) give immediate, low-cost emission & fuel savings while supporting local livelihoods.

Fuelwood dependence and alternative energy sources in Ethiopia (DNBI, 2022)

BIOMASS STOVE ANALYSIS

DOUBLE_SWITCH_

Three-Stone Open Fire

Up-front Cost:
≈ 0 Birr (local stones/clay)
Lifespan:
~ 5 years (local estimate)
Fuel Efficiency:
Very low – CCT ≈ 1,038 g/kg injera
Emissions:
High pollution & fire risk
Other Features:
Traditional; no cost but inefficient
Overall Assessment:
Baseline / inefficient

Gonzie (Clay Improved Stove)

Up-front Cost:
70–140 Birr (2014 field)
Lifespan:
7 years (if properly used)
Fuel Efficiency:
CCT 617 g/kg → ≈33.8–54.1% fuel saving in field
Emissions:
Reduces emissions 54–74%
Other Features:
Locally made, can bake injera, cook pots
Overall Assessment:
Cheapest, best value

Mirt (Cement Stove)

Up-front Cost:
≈ 220 Birr (2017 field)
Lifespan:
≈ 10 years
Fuel Efficiency:
~ 48% wood saving in tests
Emissions:
Similar to Gonzie
Other Features:
Heavier & costlier; limited rural manufacture
Overall Assessment:
Good but less scalable than Gonzie.

✅Gonzie offers ~40–50% fuel savings at half the cost of Mirt, can be made locally by potters, and is therefore the most cost-effective improved stove for the next decade.

⚠️Caveat

Durability varies with clay quality & curing; curing consumes extra wood and poor curing or wrong soil mix reduces lifespan

💡Solution:

- Improve soil-sand ratio (high sand = stronger stoves, lower cracking)
- Adopt closed communal kilns to prevent open curing (reduces 1.8× firewood waste)
- Provide maintenance training and 1-year warranty per cooperative (ensure trust)
- Standardize molds to ensure fit for different injera plates

CCT: Control Cooking Test

GONZIE STOVE: VISION AND IMPACT

50,000–75,000
local jobs

Reduces indoor air pollution by 60–70%, improving maternal and child health.

Social Impact

70% of pottery workforce traditionally women

Reduces women's fuel time by 2–3 hours daily, freeing 7–10 hours weekly for work or study

Nationwide rollout via regional offices, polytechnics, and NGO partners

Environmental impact

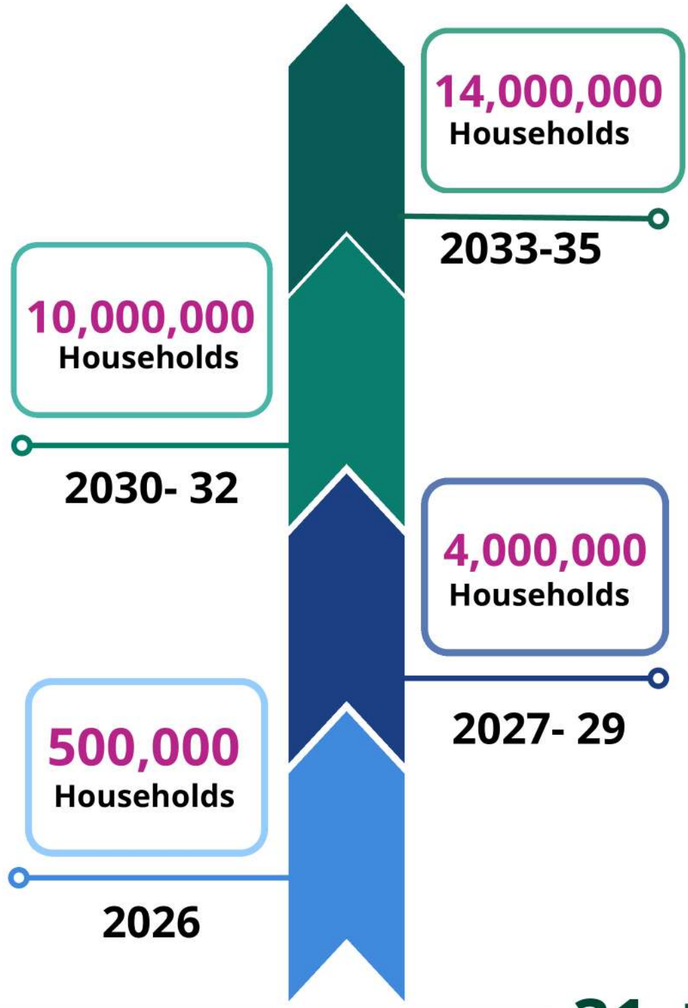
Baseline open-fire emission
1.1
tCO_2e / HH / yr

Average Gonzie reduction
64%

CO_2e saved
0.7
tCO_2e / HH / yr

Annual CO_2e saved
8.8
million tCO_2e

Implementation Vision



Willingness To Pay

Assumptions:

Daily wood used = 5.361kg/day
Fuel Saving from Gonzie = 41%
Biomass cost = 0.35 Birr/kg
Stove price = 130 Birr

Biomass	Gonzie
wood used: 5.361kg/day	wood used: 3.164kg/day
monthly cost: 56.3 Birr	monthly cost: 33.22 Birr

Payback in 7 month
Monthly Saving = 23.68 Birr

GONZIE STOVE: IMPLEMENTATION PLAN

DOUBLE_SWITCH_

Phase 1 (2026)

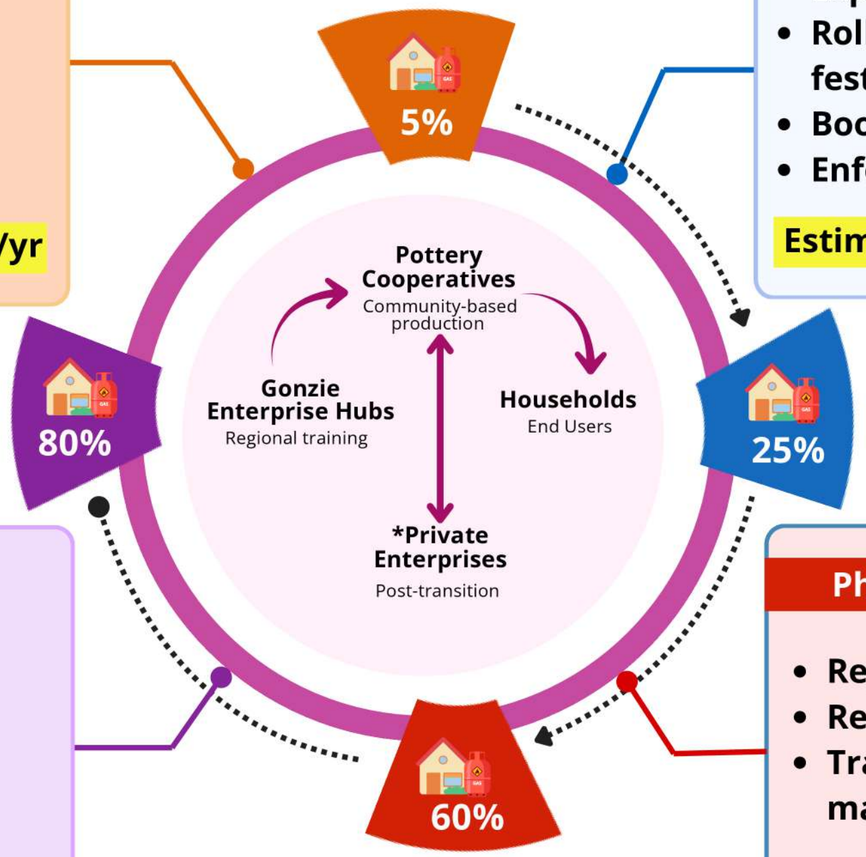
- Pilot in 5 districts: Ener Kola, Daemir, Awed, Bahir Dar Zuria & Sodo Zuria
- Set up Gonzie Hubs with shared kilns & molds
- Create Pottery Co-ops (tax-free)
- Train artisans through TVET & women's groups

Estimated Units Produced (Annual): 0.3 – 0.5 M/yr

Phase 2 (2027-2029)

- Expand hubs to all major regions
- Roll out "1 Gonzie per Home" via schools & festivals
- Boost co-ops & district kiln access
- Enforce regional quality checks (clay & curing)

Estimated Units Produced (Annual): 1.0 – 1.5 M/yr



Phase 3 (2030-2032)

- Register "Certified Gonzie" label
- Reach remote & pastoral areas via mobile hubs
- Transition co-ops to private ownership for market autonomy

Estimated Units Produced (Annual): 1.5 – 2.0 M/yr

Phase 4 (2033 - 2035)

- Replace old units (~10%/yr)
- Refurbish kilns & molds locally
- Finalize co-op to private handovers for sustained jobs & supply
- Track adoption & impact via district offices

Estimated Units Produced (Annual): 1.0 – 1.5 M/yr

TVET: Technical and Vocational Education and Training

SOLUTION:

3B.COOKING FUEL: URBAN

EXPLORING BARTER SOLUTION FOR URBAN COOKING FUEL: LPG

DOUBLE_SWITCH_

Big Picture: Barter

Partnership Between Ethiopia and Sudan leverages Ethiopia's Ogaden Basin (7 Trillion Cubic Feet proven reserves) to produce LPG(Liquified Petroleum Gas) for clean urban cooking and natural gas byproducts for fertilizer.

$8.57 billion project

Sudan provides
- experience,
- financial resources (73% of total)

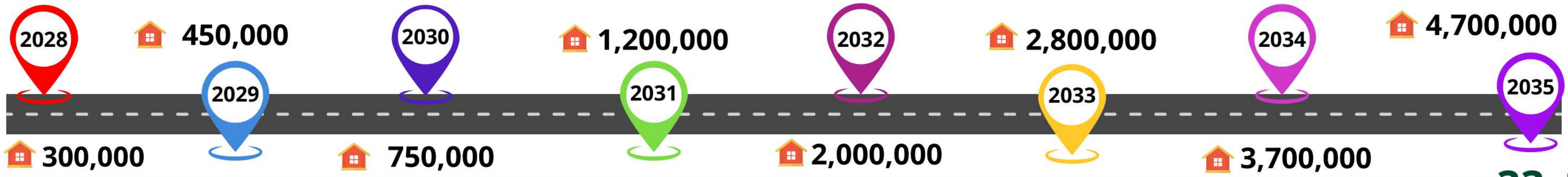
Ethiopia provides
- gas rights
- host site

60% → Output ← 40%

Why a Game-Changer ?

- Ethiopia reduces $4B/yr petroleum import bill and saves $1.5B/yr in fertilizer imports by 2030.
- Sudan secures energy, diversifies fuel mix, and strengthens regional economic ties.
- Both nations share capital burden, risk, and build technical/industrial capacity.
- LPG is the most cost-effective urban transition fuel before full electrification by 2035.

Implementation vision

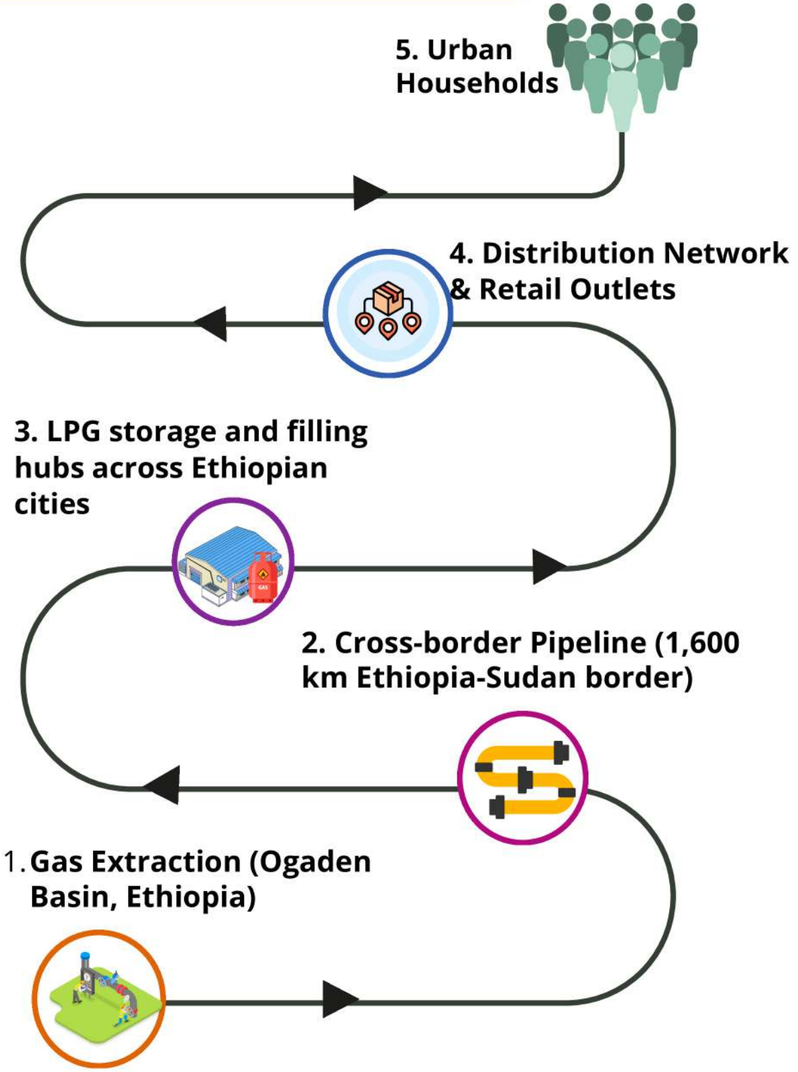


LPG: IMPLEMENTATION PLAN

Implementation Plan

(2025–2027)	(2028–2032)	(2033–2035)
Foundation & Partnership Setup	**Infrastructure Expansion & Market Rollout**	**Full Operation & Regional Integration**
01	02	03
• Ogaden Basin, Border Regions • Project agreements, reviews, and financing finalized • Design of gas fields, pipeline, LPG, and fertilizer complex • Sudanese technical expertise supports Ethiopian ramp-up	• Ogaden Basin, Addis Ababa, major Ethiopian & Sudanese cities • Build gas fields, 1,600 km pipeline, LPG plants, and cylinder network • $2.5B Gode fertilizer plant with Dangote (Ethiopia 40%) • LPG + fertilizer rollout: 1.5M Ethiopian households	• Nationwide Ethiopian cities + Sudan LPG markets • 8M Ethiopian households on LPG; 3 Mt/yr fertilizer output • Regional exports expand; project breaks even by year 4

LPG Supply Chain Flow



URBAN LPG ADOPTION AND IMPACT

WTP vs. Proposed Pricing

Income Tier	Maximum WTP	Proposed Price	Consumer Surplus
Tier 1 (Low income)	$13.50/month	$2.47/month	$11.03 (82% below WTP)
Tier 2 (Middle income)	$19.80/month	$4.32/month	$15.48 (78% below WTP)
Tier 3 (High income)	$24.00/month	$7.40/month	$16.60 (69% below WTP)

Why 98% adoption?

Assuming gas refill once a month

When prices are less than 35% of maximum WTP, adoption becomes nearly certain. Your prices range from 18-31% of WTP - well within the "automatic adoption" zone proven in India's PMUY program and Côte d'Ivoire's success

Development Impact:

Public Health:
20,000+ lives saved/year (via clean air); cuts 31M tonnes CO2 annually.

Risk Mitigation:
Ethiopia keeps resources; Sudan takes 60% offtake amid strong, low-risk LPG and fertilizer demand.

Agriculture Transformation:
Domestic fertilizer raises crop yields for 30M farms and supports agro-industry.

Regional Security:
Deepened economic integration, proven models for African development.

Post 2035 Transition

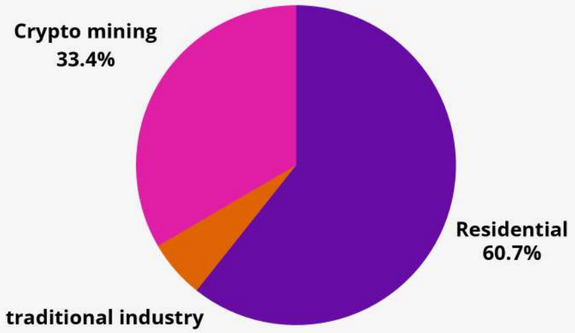
- Urban homes shift to electric cooking, with LPG as backup by 2045.
- Fertilizer output grows via gas and LPG by-products, boosting farm self-sufficiency and exports.

POLICY RECOMMENDATIONS

POLICY DECISION: CRYPTO MINING

Crypto mining consumes over one-fourth of Ethiopia's total electricity output, threatening grid stability.

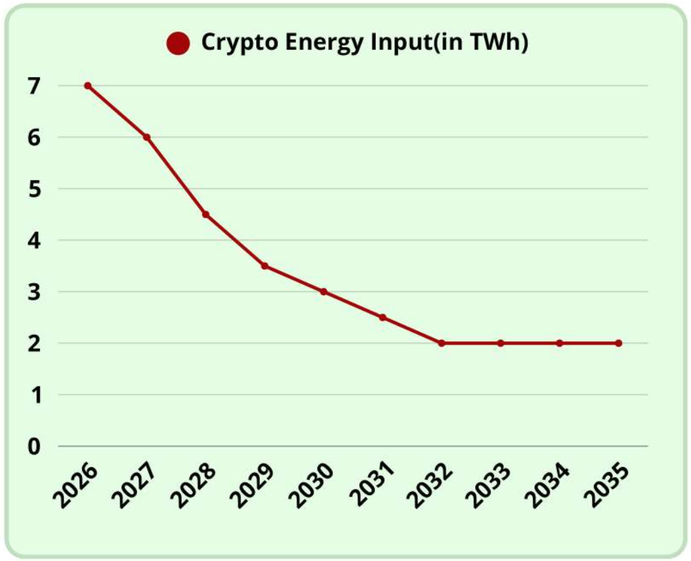
Energy Consumption in different sectors in Ethiopia



National Electrification Programme 3.0 urgently calls to phase out crypto mining, as 2025–2027 are critical years for Ethiopia's energy stability and growth.

Policy

To slowly phase out Crypto Mining operation by systematically increasing tariffs



Current tariffs
$3.14
cents per kWh

→ **Current Load**
8 TWh

Final tariffs
$9.42
cents per kWh

→ **Expected Load**
2 TWh

The freed capacity enables:

- **Electricity demand surged: Residential and commercial use rose 14.52→19.78 TWh, while industrial demand grew 1.41→3.76 TWh despite limited new generation.**
- **Efficiency and flexibility improved: System losses dropped 23%→13.7%, and flexible tariffs help manage load growth from crypto and data-mining operations.**

"Crypto Boom Makes For Power Burden In Ethiopia" — The Reporter Ethiopia, 2025, "EEP To Phase Out Crypto Mining As Grid Strain Concerns ..." — The Reporter Ethiopia, 2025

FINANCIAL MODEL

ELECTRICITY BUDGET

ON GRID INFRASTRUCTURE $5954M

Component	Total Budget (USD M)	% of Total
Smart Meters (5.9M units @ $60/unit)	354	5.90%
Smart Grid Infrastructure (AMI, SCADA, MDMS, Comms)	800	13.40%
Distribution Network Upgrades (115,004 km)	2,500	42.00%
Transmission System Upgrades (19,305 km)	1,500	25.20%
Substations (160 new + 39 upgrades)	800	13.40%
TOTAL	5,954	

Funding Category	Net Amount (USD M)	% of Total Funding (Loans + Grants + Domestic)
Concessional Loans	1,103.20	18.50%
Grants (Non-repayable)	3,606.40	60.60%
Ethiopia Direct Contribution (Gov + Private + EEP)	1,244.40	20.90%
TOTAL FINANCING	5,954	

SOMALIA WIND INTEGRATION $520.7M

Component	Total (USD M)	% of Total
Wind Farm (180 MW)	280	53.80%
Grid Infrastructure (100 km, 230kV)	120	23.10%
Battery Storage (100 MW/400 MWh)	80	15.40%
Distribution Network (1.17M HHs)	40.7	7.80%
SCADA & Metering Systems	10.3	2.00%
Contingency & Management	9.7	1.90%
TOTAL	520.7	

Funding Category	Net Amount (USD M)	% of Total Funding (Loans + Grants + Domestic)
Concessional Loans	162.2	31.20%
Grants (Non-repayable)	162.2	31.20%
Ethiopia Direct Contribution (Gov + EEP + Private)	216.3	41.60%
TOTAL FINANCING	520.7	100%

OFF GRID FINANCIAL BUDGET

DOUBLE_SWITCH_

OROMIA WIND INTEGRATION $720M

Component	Total (USD M)	% of Total
Wind Capacity (450 MW)	450	62.50%
Transmission Upgrades (150 km)	150	20.80%
Distribution Network	70	9.70%
BESS (150 MW/600 MWh)	50	6.90%
Substations & SCADA	30	4.20%
Contingency & Management	36	5.00%
TOTAL	720	

Funding Source	Net Amount (USD M)	% of Total Project (720 M)
Grants (Non-repayable)	196.5	27.30%
Concessional Loans	275.1	38.20%
Ethiopia Direct Contribution	248.4	34.50%
TOTAL FINANCING	720	

SOLAR HOME SYSTEM $1538M

Component	Total (USD M)	% of Total
SHS Units & Deployment	1,200.00	77.90%
Assembly & Labor	160	10.40%
IT Systems & Fin-Tech	54	3.50%
Training Programs	40	2.60%
Quality Assurance	24	1.60%
Logistics & Contingency	60	4.00%
TOTAL	1,538.00	

Funding Source	Net Amount (USD M)	% of Total Project (1,538 M)
Grants (Non-repayable)	615.2	40.00%
Concessional Loans	384.5	25.00%
Ethiopia Direct Contribution	538.3	35.00%
TOTAL FINANCING	1,538.00	

AfDB– Ethiopia Wind Energy Project Approvals, ACE TAF – Stand Alone Solar Investment Market Map – Ethiopia (2021), World Bank – A Solar Panel Can Change a Life: Behavioral Diagnostic Note (2024)

ELECTRICITY BUDGET

DOUBLE_SWITCH_

GEOTHERMAL $5954M

Component	Total (USD M)	% of Total
Drilling & Exploration	250	22.70%
Plant Construction Phase 1	350	31.80%
Plant Construction Phase 2	200	18.20%
Transmission & Grid	150	13.60%
Substations & SCADA	90	8.10%
Contingency & Management	60	5.50%
TOTAL	1,100.00	

Funding Source	Net Amount (USD M)	% of Total Project (1,100 M)
Grants (Non-repayable)	275	25.00%
Concessional Loans	385	35.00%
Ethiopia Direct Contribution	440	40.00%
TOTAL FINANCING	1,100.00	

TOTAL GRANTS (ALL PROJECTS) $2496M

Source	Amount (USD M)	%
World Bank	1,200	32%
Green Climate Fund	577	15%
AfDB – SEFA	95	3%
UNDP & GEF	115	3%
EU (RISED)	250	7%
Nordic Dev. Fund	100	3%
Bilateral Donors	88	2%
GRMF	70	2%
Total Grants	2,496	32%

TOTAL LOANS (ALL PROJECTS) $4363M

Source	Amount (USD M)	%
World Bank IDA	789	10%
AfDB	403	5%
JICA	116	2%
Carbon Finance / PAYG	80	1%
On-grid concessional	2,977	38%
Total Loans	4,363	56%

COOKING FINANCIAL BUDGET

DOUBLE_SWITCH_

ON GRID COOKING — $2297M

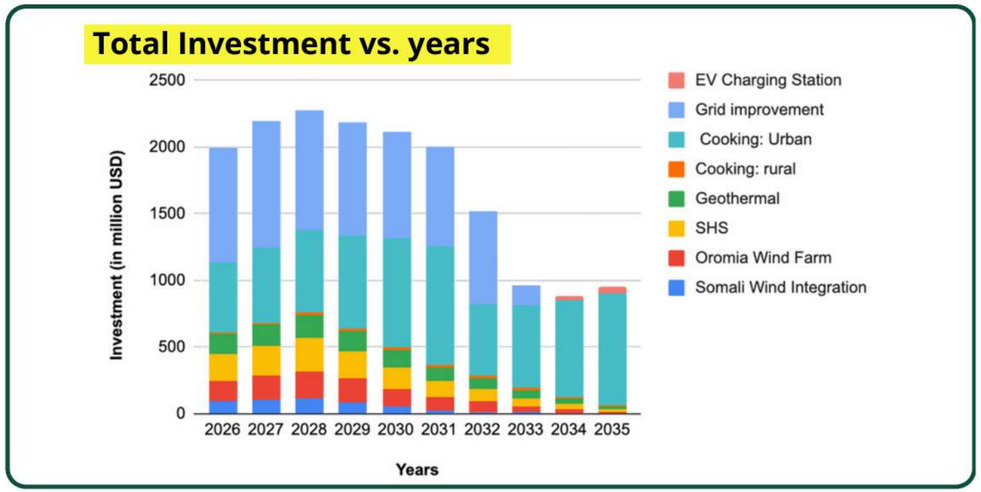
Component	Total Cost	Sudan Pays	Ethiopia Pays
LPG Production Plant	$2,286M	$1,372M (60%)	$914M (40%)
Gas Field Development	$1,000M	$500M (50%)	$500M (50%)
Pipeline - Ethiopia Segment	$1,842M	$1,289M (70%)	$553M (30%)
Pipeline - Sudan Segment	$3,070M	$3,070M (100%)	$0M (0%)
LPG Terminal & Storage	$75M	$45M (60%)	$30M (40%)
Ethiopia Distribution	$300M	$0M (0%)	$300M (100%)
TOTAL	$8,573M	$6,276M	$2,297M

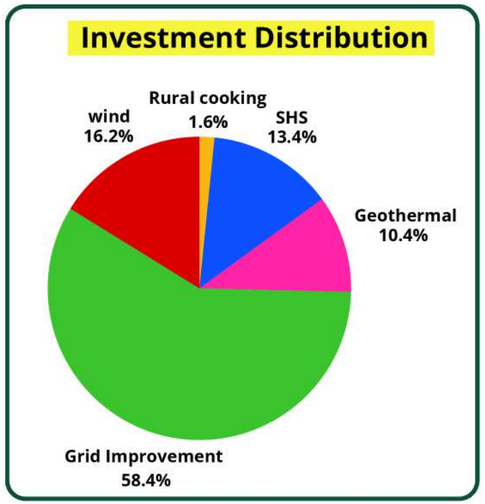
OFF GRID COOKING — $157.9M

Component	Total (USD M)	% of Total
Training & Certification	27.6	17.50%
Shared Kilns & Molds	34.9	22.10%
Quality Assurance & Monitoring	25.3	16.00%
Outreach & Community Engagement	22.6	14.30%
Coordination & PMO	47.5	30.10%
TOTAL	157.9	

FINANCIAL MODEL

Component / Year	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Somali Wind Integration	100	110	120	90	50	25	15	10	5	5
Oromia Wind Farm	150	180	200	180	140	100	[illegible]	50	30	10
SHS	200	220	250	200	160	120	90	60	40	20
Geothermal	150	160	170	150	130	100	80	60	40	20
Cooking: Rural	14.2	14.2	17.8	17.8	19.3	19.3	19.3	12	12	12
Cooking: Urban	525	567	618	702	815	889	537	619	722	841
Grid improvement	850	950	900	850	800	750	700	154	0	0
EV Charging Station	0	0	0	0	0	0	0	0	38.7	46
Total Investment	1989.2	2201.2	2275.8	2189.8	2114.3	2003.3	1521.3	965	887.7	954

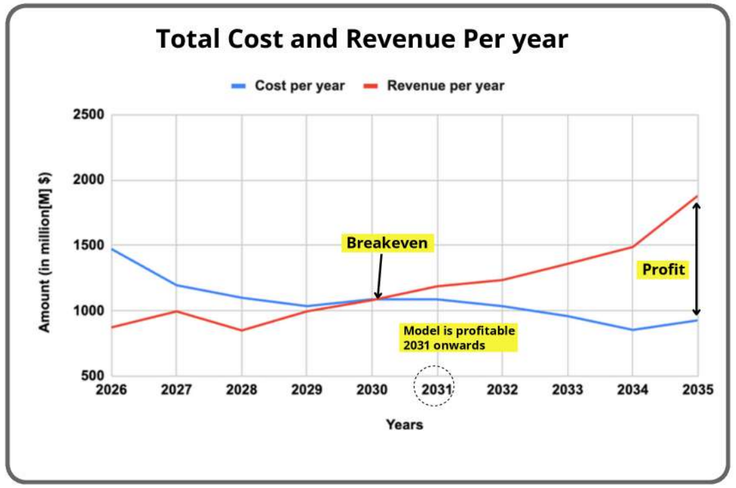




Peak investment in 2028 drives grid modernization (≈58% share) and renewable expansion (≈27%). Clean cooking and SHS components ensure rural inclusion, supporting Ethiopia's shift toward a diversified, low-carbon energy mix.

BREAK EVEN ANALYSIS

Year	2026	2027	2028	2029	2030	Breakeven Point 2031	2032	2033	2034	2035	Total
Cost per year (USD M)	1,472.80	1,195.40	1,099.60	1,035.50	1,087.90	1,087.20	1,035.10	959.1	853.7	927.1	10,753.40
Revenue per year (USD M)	872.8	995.4	849.6	995.5	1,081.50	1,187.20	1,235.10	1,359.10	1,488.00	1,881.10	11,945.30



Funding Stage	Amount (USD M)	Cumulative (USD M)	% of Total
1. Grants (GCF, WB, AfDB, EU, Nordic, bilateral)	2,496	2,496	29.50%
2. Concessional Loans (WB IDA, AfDB, JICA)	4,363	6,859	51.60%
3. Government Equity (Federal budget, EEP, bonds)	1,468	8,327	17.40%
4. Private Sector Investment (PAYG, LPG operators)	126	8,453	1.50%

Breakeven Year	2031 (Year 6)
Peak Investment Year	2028 (USD 2.28B)
Total Cost (10-year)	USD 10.75B
Total Revenue (10-year)	USD 11.95B
Net Cumulative Profit	USD 1.19B
Post-Breakeven Profit	USD 2.29B
Unique house holds reached	29.2M+

Assumptions for Revenue Model:

- Avg. cost: $0.04/kWh as base (2026), avg. family size 4.4 persons.
- Annual use: Urban – 3,500 kWh, Rural – 1,500 kWh.
- Blended avg. consumption: ~2,500 kWh/year (25% urban, 75% rural).
- Business/minigrid tariff: $0.15/kWh, collection efficiency 92%.
- 2–3% annual tariff rise for inflation adjustment.

Pre-Breakeven (2026–2030): Cumulative Loss USD 1,096M

- Investment-heavy phase
- Debt servicing focus
- Grants + loans finance majority (70%)

Post-Breakeven (2031–2035): Cumulative Profit USD 2,288M

- Revenue exceeds costs by average USD 319M/year
- 60% of annual profit reinvested in debt repayment
- 40% available for operational expansion + dividend

IMPACT ANALYSIS

IMPACTS

The 10-year energy model demonstrates substantial alignment with 16 out of 17 Sustainable Development Goals

1. Clean energy access increases income and resilience.

2. Solar irrigation improves food security and livelihoods.

3. Clean cooking cuts indoor pollution and diseases.

4. Energy training strengthens education and workforce skills.

5. Women gain jobs, leadership, and time equality.

6. Solar irrigation ensures clean, efficient water use.

7. Renewables deliver universal, affordable clean energy.

8. Energy investments drive jobs and economic growth.

9. Smart grids and storage modernize infrastructure.

10. Decentralized renewables reduce social and economic inequality.

11. Clean energy enhances urban health and sustainability.

12. Efficient systems promote sustainable resource use.

13. Renewable energy strengthens national climate resilience.

15. Clean cooking curbs deforestation and protects ecosystems.

16. Smart meters ensure transparency and strong institutions.

17. Regional bartering fosters integrated sustainable partnerships.

ETHIOPIA ENERGY TRANSFORMATION (2025-2035): MAJOR IMPACTS BY CATEGORY

DOUBLE_SWITCH_

01 SOCIAL IMPACT

- Clean cooking cuts illness and indoor pollution.
- Women gain income, education, and empowerment.
- Female jobs boost asset ownership and equality.
- Modern cooking and electrification improve comfort.
- Clean cooking enhances nutrition and food security.

02 ECONOMIC IMPACT

- Domestic energy replaces costly fuel imports.
- Expands pottery, battery, and grid manufacturing.
- Boosts local jobs, exports, and fiscal stability.
- Smart meters and solar systems generate income.
- Renewable industry builds national assets and carbon credit inflow.

03 POLITICAL IMPACT

- Renewables reduce foreign energy dependence.
- Builds regional trade via power interconnections.
- Strengthens cooperation with Sudan, Kenya, Djibouti.
- Enhances public trust and government legitimacy.
- Smart grids and SCADA improve transparency.

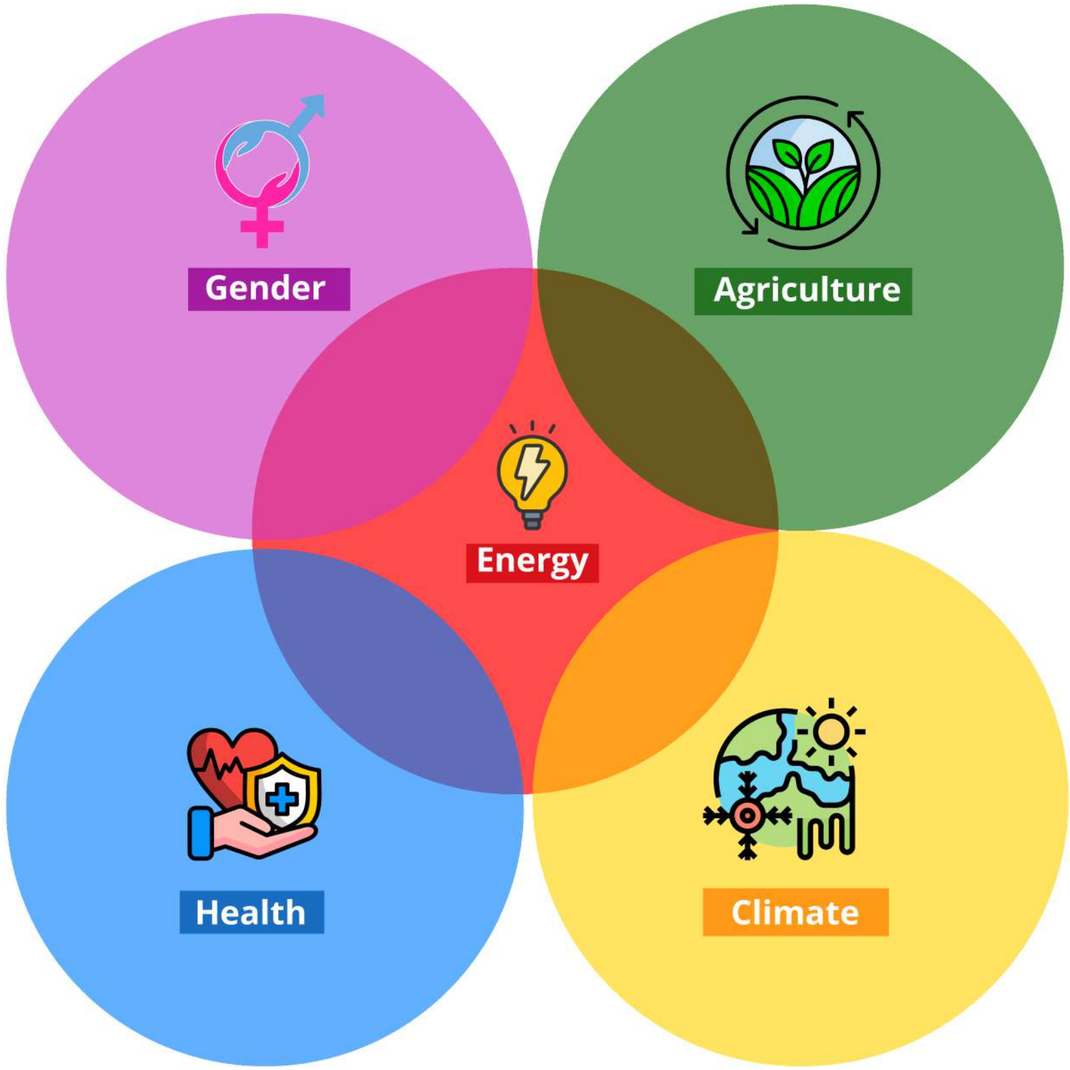
04 ENVIRONMENTAL IMPACT

- Clean cooking cuts biomass use by 90%.
- Forest recovery protects biodiversity and watersheds.
- Reduces erosion, improves soil and fertility.
- Enhances air quality and lowers emissions.
- Supports sustainable agriculture and CO_2 reduction.

05 INDUSTRIAL IMPACT

- Expands agro-processing and clean industries.
- Strengthens grid, transport, and manufacturing sectors.
- Boosts reliability through SCADA and smart meters.
- Grows battery, solar, and EV industries.
- Creates skilled jobs and supply-chain capability.

MULTIPLIER INTEGRATION POINTS



Energy × Agriculture:

Fertilizer by-products + solar irrigation double productivity over 1.05M hectares, benefiting 30M farmers.

Energy × Health:

Lower indoor pollution + electrified clinics + improved nutrition strengthen health systems.

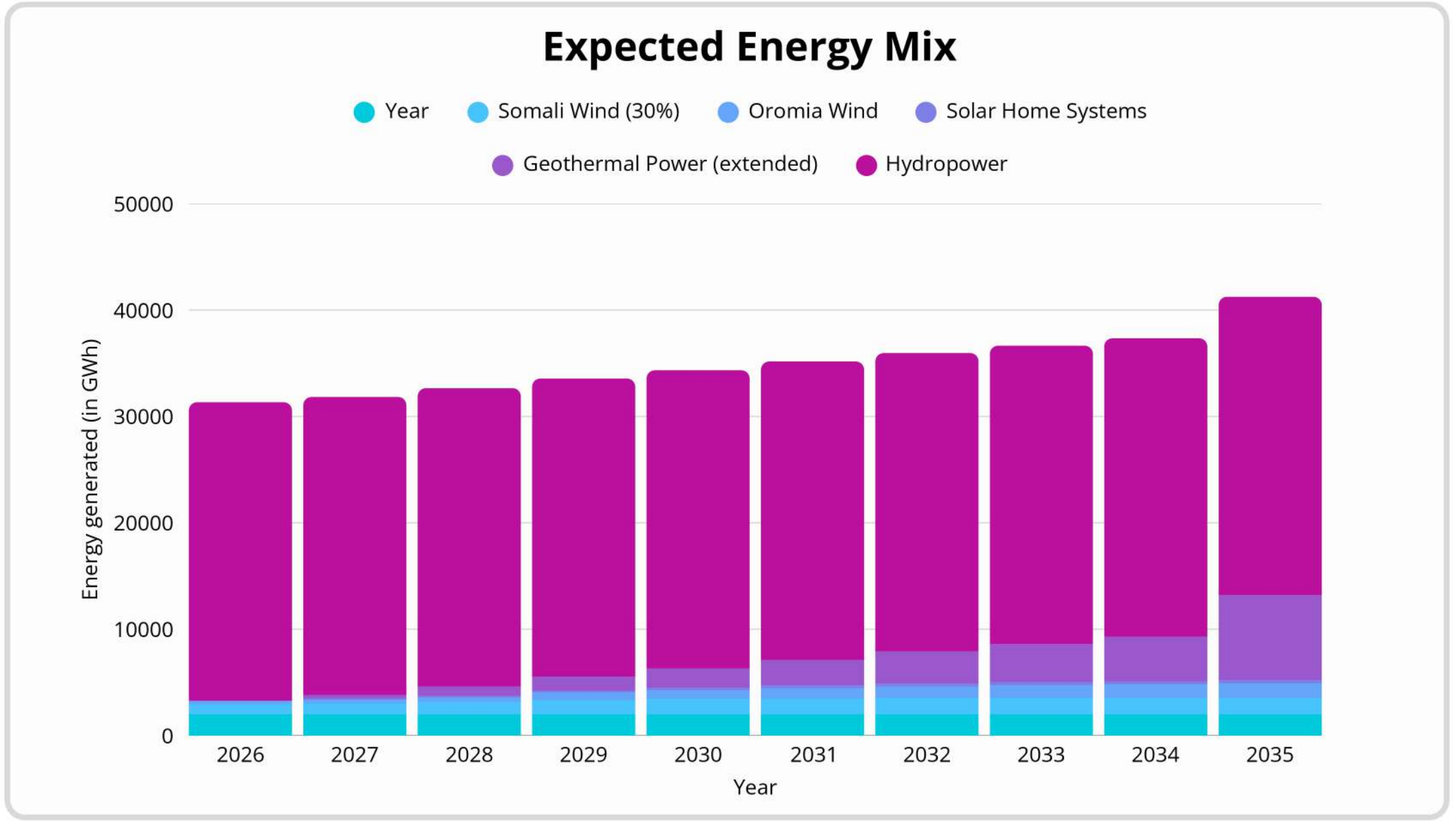
Energy × Climate:

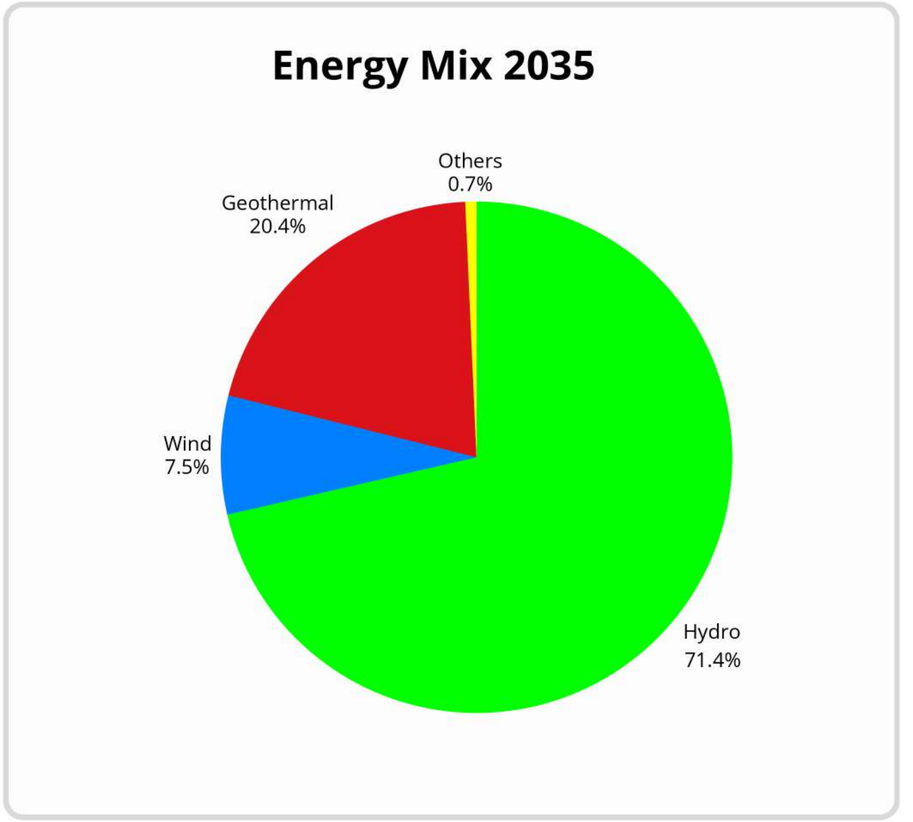
CO_2 reduction (31M tonnes), forest preservation, and watershed protection enhance climate resilience.

Energy × Gender:

Time savings + employment + leadership networks deliver systemic gender transformation.

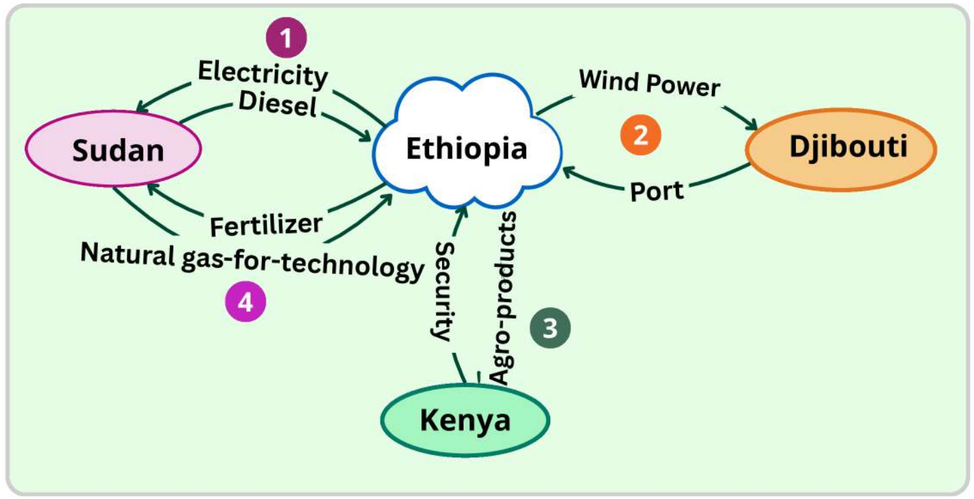
ENERGY SCENARIO 2035





- **Geothermal power rises to over 20%, providing year-round base-load and reducing hydro seasonality risk.**
- **Losses drop sharply from 23% to 13.7%. Wind and solar expansion supports grid stability.**
- **Electricity demand booms, residential/commercial jumps 36% and industrial demand more than doubles.**
- **Ethiopia achieves a diversified, resilient, and future-ready energy system, supported by flexible tariffs for emerging sectors.**

BARTER IMPACT



Global Energy Poverty & Geopolitical Gains

- Barter partnerships replaced extractive trade with mutual growth, building resilient Pan-African energy chains.
- Enabled East African grid integration, cutting fuel costs and powering industrialization.
- Strengthened negotiating power with global investors (e.g., BRI, AfCFTA).
- Clean Ethiopian power exports reduced diesel use and CO_2 emissions across the region.
- Energy diversification and Ethiopia–Sudan partnerships aligned GERD power generation with Sudan's water needs for strategic cooperation.

Barter reshaped East Africa's energy landscape—making it stronger, cleaner, and globally influential beyond what one-sided trade could achieve!

1

Ethiopia: Sustained urban and industrial power (263M L diesel= $210M saved) during grid rewiring.
Sudan: Restored power post-RSF drone strikes using Ethiopia's renewables, avoiding diesel generation losses.

2

Djibouti: Gained clean, reliable power from Ethiopia, cutting diesel use and earning $1.5–2B/year from port trade.
Ethiopia: Became a regional power hub, exporting 1,062 GWh/year and saving millions via lower port costs and reduced emissions.

3

Kenya: Received $12.8M+ in Ethiopian pulses, easing shortfall.
Ethiopia: Gained Kenyan military support securing energy sites, expanded agro-exports.

4

Ethiopia: Saved $5.5B in fuel and fertilizer imports, enabled LPG for 8M homes, boosted 30M farms, launched a $2.5B Gode fertiliser plant.
Sudan: Diversified fuels, gained tech access, improved energy security, and secured 60% of LPG/gas output.

RISK ANALYSIS

Grid Modernization: Ensuring a Stable & Equitable Rollout

Risk (System Failure):
New grid tech may fail if poorly designed.
Mitigation (Pilot Program):
Pilot in Addis Ababa to test design, finance, and governance before national rollout.

Risk (Regional Tension):
Uneven upgrades may cause political friction.
Mitigation (Equitable Rollout):
Phased national expansion ensures fair regional benefits

Off-Grid Solar: Overcoming Adoption Barriers

Risk (Low Adoption):
High SHS upfront costs limit rural access.
Mitigation (PAYG Model):
The PAYG model turns high SHS costs into affordable monthly payments, making solar cheaper than kerosene and boosting adoption and sustainability.

Renewable Energy Integration: Guaranteeing Reliability

Risk (Grid Instability):
Intermittent wind threatens grid stability.
Mitigation (BESS & Geothermal):
Use battery storage and geothermal baseload to ensure 24/7 reliable power, balancing variable renewables like solar and wind and maintaining stable grid supply even during peak demand or low-generation periods.

Clean Cooking Solutions: Driving Confident Adoption

Risk (Poor Stove Quality):
Inconsistent "Gonzie" stoves reduce trust.
Mitigation (Quality Control):
Standardized build, better materials, 1-year warranty for reliability.

Risk (Low LPG Adoption):
Slow uptake threatens financial viability.
Mitigation (Price Incentive):
LPG priced 18–31% below willingness-to-pay to drive adoption.

VISION 2050

DOUBLE_SWITCH_

Targets

1. Solar Energy Dominance
2. Geothermal Baseload Expansion
3. Grid Infrastructure Modernization
4. Net Zero & Climate Action

COLLABORATIVE CLEAN ENERGY INITIATIVES

Solar Manufacturing & Export Hub
Ethiopia builds a $1.75B solar factory (2+ GW/year) to supply Africa, boost jobs, and end import reliance.

Green Hydrogen Corridor
50 GW renewables drive Africa's lowest-cost green hydrogen ($1–2/kg), powering industry and exports.

East African Renewable Power Grid
Cross-border grid and 35+ GW wind connect 4 countries, enabling stable power for 150 million people.

RECOMMENDED POLICIES

Renewable Mandate: Legally require 100% renewables by 2050; ensure utility transition.
Carbon & Incentives: Tax polluters, exempt renewables, fund 3M households' clean cooking.
Industrial Competitiveness: Fast permits, green-powered SEZs, mandate local tech transfer.
Just Transition: Retrain 300,000+ (40% women), skill 50,000+ rural renewables technicians.

No Single Solution for Global Energy Poverty!

No, there is not a single global solution that can end energy poverty. The best approach is a unified ecosystem of decentralized renewables combined with affordable financing, community ownership, and local workforce development. This approach reaches remote populations more efficiently and effectively than centralized mega-projects and is recognized as the fastest, most cost-effective path to universal access by the UN and WHO.

REFERENCES

REFERENCES 1

DOUBLE_SWITCH_

Demographic Information
Country Economy: https://countryeconomy.com/countries/compare/ethiopia
Wikipedia: https://en.wikipedia.org/wiki/Ethiopia
Global Economy (GDP): https://www.theglobaleconomy.com/Ethiopia/GDP_current_USD/
World Bank Group: https://www.worldbank.org/en/country/ethiopia/overview
UNDP Human Development: https://www.undp.org/africa/publications/ethiopia-national-human-development-report
UNESCO Literacy: https://www.iicba.unesco.org/en/ethiopia

Energy Assessment
Electricity Access: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ET
SDG7 Overview: https://trackingsdg7.esmap.org/data/files/download-documents/et.pdf
IEA Country Outlook: https://www.iea.org/countries/ethiopia
Reliability & Outages:
https://sciencedirect.com
https://researchgate.net
Distribution Losses: https://helgilibrary.com/indicators/electric-power-distribution-transmission-losses-as-of-output/ethiopia/
Electrification Program: https://www.powermag.com/wp-content/uploads/2020/08/ethiopia-national-electrification-program.pdf
Safety: https://addisfortune.news/utility-expands-smart-metre-installation-to-curb-power-theft-improve-service/?utm_source=chatgpt.com

Regional Energy Prospect
Kenya:
https://iea.org
https://trade.gov
https://cnn.com
https://kenyatradedata.com
Djibouti:
https://african.business
https://worldbank.org https://mei.edu

REFERENCES 2

Sudan:
https://wiley.com
https://andariya.com
Eritrea:
https://en.wikipedia.org/wiki/Energy_in_Eritrea
https://linkedin.com
South Sudan:
https://worldbank.org
https://reuters.com
Somalia:
https://openknowledge.worldbank.org/handle/10986/34583
https://sciencedirect.com

Energy State & Solutions
GERD/Resources: https://globalconstructionreview.com/ethiopia-inaugurates-grand-renaissance-dam-after-14-years-of-construction
Hydro Risks:
https://climatechangenews.com
https://nature.com,
https://reuters.com
Transmission Grid/Projects:
https://worldbank.org
https://ecofinagency.com
Grid/Rural Expansion: https://powermag.com
https://humanitarianenergy.org

On/Off Grid & Diversification
Solar: https://thedocs.worldbank.org
Wind: https://um.dk

REFERENCES 3

Geothermal:
https://documents1.worldbank.org
https://rafhladan.is
Transport, Cooking, Additional Policy EV Charging:http://english.news.cn

Cooking & Clean Energy: Kedir, M.F. et al., “Problems of Mirt, and potentials of improved Gonzie

IEA Policy/Crypto:
https://reporterethiopia.com

Finances:
World Bank Universal Access Program (total electrification project cost and national tariff models):
https://esgnews.com/world-bank-to-loans-ethiopia-1-72-billion-for-power-water-supply-expansion/
https://africabusinesscommunities.com/finance/world-bank-approves-500m-to-support-ethiopias-universal-electricity-access-by-2025/
Wind Farm Project Cost & Financing Example (Assela, sector benchmark):
https://www.africaceovoices.com/ethiopia-secures-us132m-from-danske-bank-to-fund-asselas-wind-power-project/
Geothermal Financing and Investment (World Bank/AD Bank):
https://afdb.africa-newsroom.com/press/african-development-bank-welcomes-10-million-clean-technology-fund-investment-to-diversify-ethiopias-energy-mix?lang=en
https://documents1.worldbank.org/curated/en/099120923195519746/pdf/P13361304f7fc2056080be0de223388e48d.pdf
UNDP Financing Ethiopia’s Green Transition (national budget, average cost, and donor impacts):
https://www.undp.org/sites/g/files/zskgke326/files/2025-02/undp-working_paper_series-financing_ethiopias_green_transition_final.pdf
Solar Home Systems—Cost Models and Mass Deployment Financing:
https://thedocs.worldbank.org/en/doc/48d14fadc2878533e02e3aa56066cb73-0010012025/original/Ethiopia-National-Energy-Compact-Mission-300.pdf

SWITCH ENERGY CASE COMPETITION 2025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