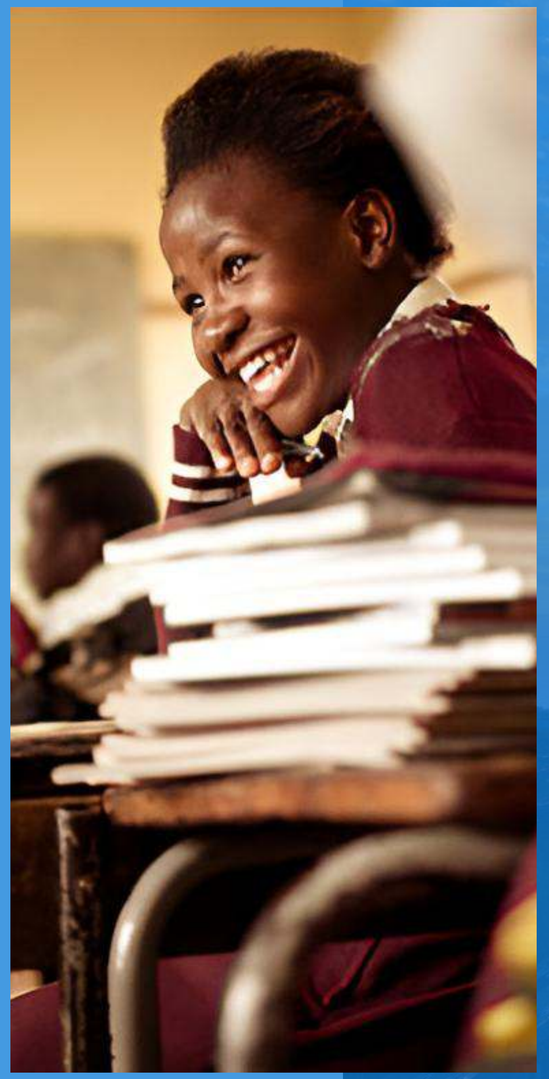
SWITCH ENERGY CASE COMPETITION 2024

TEAM ENERGY NEXUS

Our selected Country Pair : Senegal & Namibia



Our mission is to end energy poverty in Senegal by 2034 through sustainable and equitable solutions. We aim to expand clean energy access, strengthen local capacity, and drive economic growth, creating a resilient and renewable energy sector for a sustainable future.

Home country : India

Team Number : 151

MENTOR Brad Gouge

TEAM MEMBERS Bhumi Periwal, Sanika Kole, Kunal Prasad, Md Merajuddin Ahmed

EXECUTIVE SUMMARY

ENERGYNEXUS

DEMOGRAPHIC DATA, ENERGY TIMELINE AND POVERTY FACTORS OF BOTH NATIONS

DEMOGRAPHIC INFORMATION OF SENEGAL

ENERGYNEXUS

Annual GDP : **$31,041M**
Per-Capita GDP : $1,838

Capital : **Dakar, 14 regions**

HDI Ranking : **169 out of 193**

Unemployment Rate : **3.32%**

Literacy Rate : **57.67%**

Main economic sectors :
50.79% service , 23.7% industry and 16.37% agriculture

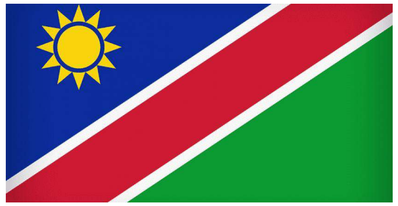
Population : **16,876,720**

Religion: **97.2% Muslims, 2.7% Christians**

Area: **196,710 km*2**

Language : **French**

Adapted from Country Economy Website



DEMOGRAPHIC INFORMATION OF NAMIBIA

ENERGYNEXUS

Annual GDP : **$12,351M**
Per-Capita GDP : $4,758

Capital : **Windhoek, 14 regions**

HDI Ranking : **142 out of 193**

Unemployment Rate : **19.6%**

Literacy Rate : **92.25%**

Main economic sectors :
54.2% service, 29.7% industry and 8.38% agriculture

Population : **2,596,000**

Religion: **97% Christians, 3% includes Muslims, Buddhists & Atheists**

Area: **824,290 km*2**

Language : **Indigenous, European and Portuguese**

Adapted from Country Economy Website

ENERGY TIMELINE OF SENEGAL

ENERGYNEXUS

1960

Senegal gained independence; the energy sector primarily dependent on biomass.

1970

Initial oil exploration with modest discoveries but no significant production.

1980

Introduction of petroleum refining at the Société Africaine de Raffinage (SAR) in Dakar.

2000

First wind energy projects and increased focus on renewable energy potential.

2010

Government launches the Emerging Senegal Plan (PSE) to diversify the energy mix.

2016

Senegal begins the development of the Grand Tortue Ahmeyim (GTA) gas project.

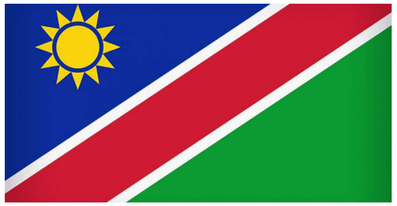
2020

First solar parks operational; significant investments in renewable energy

2023

Plans to start oil and gas production from GTA.

Adapted from various sources listed in the References



ENERGY TIMELINE OF NAMIBIA

ENERGYNEXUS

1990

Namibia gained independence; energy sector heavily dependent on hydroelectric power from Ruacana Dam and electricity imports.

1994

NamPower established to manage electricity distribution and energy infrastructure.

1996

Start of offshore oil exploration; Kudu Gas field discovered but not developed immediately.

2010

Government introduces renewable energy policies to diversify energy sources.

2014

Plans to develop Kudu Gas-to-Power project gain momentum but face delays.

2016

Establishment of first significant solar power plants as part of renewable energy strategy.

2022

Renewable energy capacity expands with new wind and solar projects.

2023

Namibia continues development of the oil and gas sector while promoting green hydrogen and renewable energy.

ENERGY POVERTY FACTORS OF SENEGAL

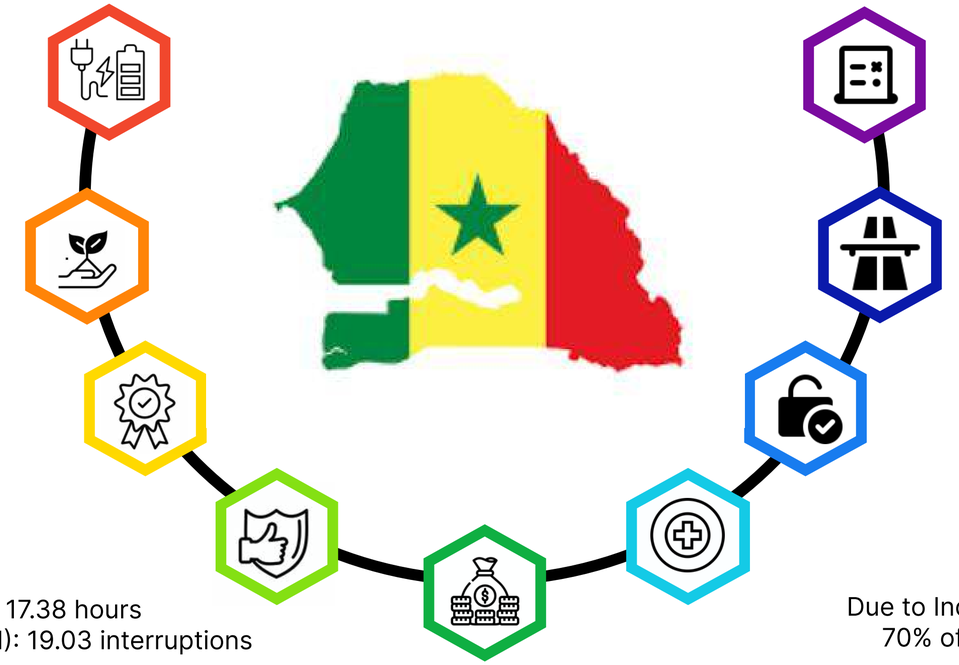
ENERGYNEXUS

Accessibility:
75% Electrification (urban 97%, rural 55%)
32% Clean cooking fuels (Urban: 59.1% & Rural: 7.4%)

Environmental impact:
10.2 Mton of CO_2 generated annually
Per-capita emissions are 0.62 metric tons
53% of TFEC is fossil-fuel based

Quality of energy services:
Transmission & Distribution losses: 12.87%
Collection efficiency: 93%
70% households suffer of voltage irregularities

Reliability:
Average Interruption Duration (SAIDI): 17.38 hours
Average Interruption Frequency (SAIFI): 19.03 interruptions



Affordability:
Average electricity cost for households is $0.24USD per kWh & $0.3136 per kWh for businesses
Energy cost 13% of rural households monthly income

Political redirection:
Senegal's 2024 elections showcase youth support for democratic reforms, reflecting their desire to shape the nation's future.

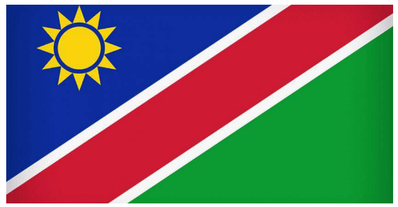
Potential for roadblocks:
Economic vulnerability due to agricultural dependence and social inequality.

Security:
59% reliance on imported fossil fuels for energy supply
Vulnerable to global oil price fluctuations
Import around 9.6% of its energy need

Safety:
Due to Indoor air pollution, 47% of deaths attributed
70% of rural households use biomass for cooking

SAIFI : No of electricity cuts/ year/customer
SAIDI : No of hours of power cut/ year/customer
TFEC : Total final energy consumption

Adapted from various sources listed in the References



ENERGY POVERTY FACTORS OF NAMIBIA

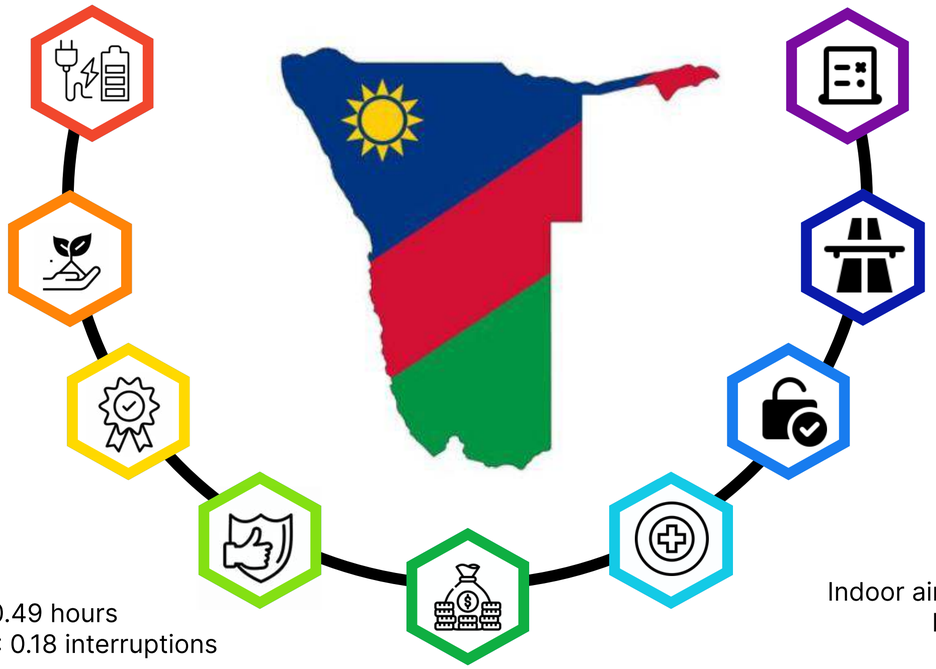
ENERGYNEXUS

Accessibility:
56.2% Electrification (Urban: 74.8% & Rural: 33.2%)
47% Clean cooking fuels (Urban: 71% & Rural: 13.5%)

Environmental impact:
4.3 Mton of CO_2 generated annually
Per-capita emissions are 1.87 metric tons
Maximum Electricity generated from renewable sources

Quality of energy services:
Transmission & Distribution losses: 9.7%
Collection efficiency: 95%
Voltage fluctuations & Blackouts occur in rural areas

Reliability:
Average Interruption Duration (SAIDI): 0.49 hours
Average Interruption Frequency (SAIFI): 0.18 interruptions



Affordability:
Current energy cost per kwh unit: $0.147 USD
High dependency on biomass is costly

Political redirection:
Namibia's 2024 election features its first female presidential candidate, signaling progress in gender equality within a strong democratic system

Potential for roadblocks:
Issues of corruption, economic inequality, and limited access to services in rural areas, alongside environmental challenges such as water scarcity

Security:
Heavy reliance on imported electricity which is 60% of its total energy consumption
local renewable energy project improving the situation

Safety:
Indoor air pollution exist in rural areas due to biomass use
Lower concerns in urban areas due to better grid infrastructure, Faces lower health risks

SAIFI : No of electricity cuts/ year/customer
SAIDI : No of hours of power cut/ year/customer

Adapted from various sources listed in the References

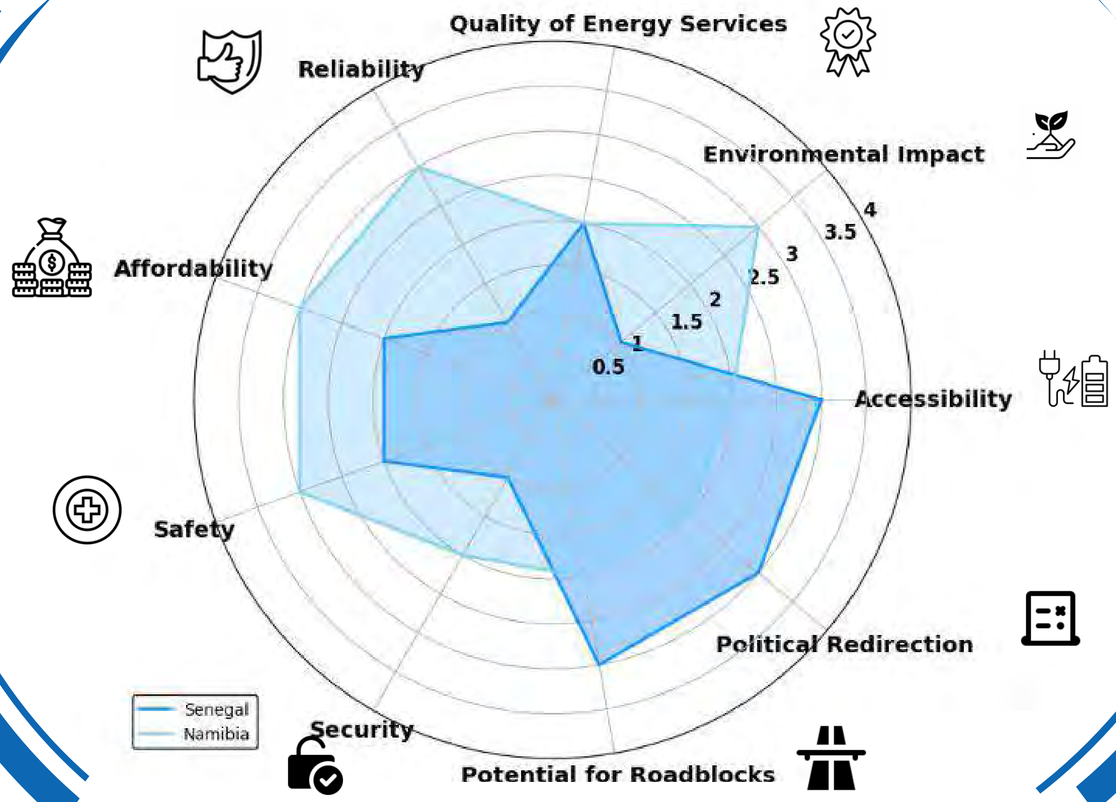
COMPARATIVE ANALYSIS OF SENEGAL AND NAMIBIA

ENERGYNEXUS

Country name :
SENEGAL

Overall country score:

18



Country name :
NAMIBIA

Overall country score:

22

WHY SENEGAL??

Based on overall scores and budget, we chose to find a solution for Senegal, which can later be adapted for Namibia.

*Appendix made by our team is added at the end of the presentation

ENERGY STATE OF SENEGAL &

ISSUE ANALYSIS

SPECIFIC ENERGY RESOURCES OF SENEGAL

ENERGYNEXUS

FOSSIL FUEL

Natural Gas
Central to Senegal's energy strategy, used for electricity generation and as a transition fuel. Concerns about long-term dependency on gas infrastructure limiting future flexibility.

Diesel and Coal
Temporary stop-gaps in the energy mix, set to decline as renewables expand. Strategic aim to phase these out to lower emissions.

Oil
Historically major, mostly for transportation and power. Caution around expanding due to environmental and market volatility concerns.

Biomass
Traditional fuel like firewood and charcoal are widely used for cooking in rural areas, but contribute to deforestation and pollution. Sustainable solutions are being explored.

RENEWABLES

Solar and Wind
Key to reaching 40% renewables by 2030. Abundant solar and favorable wind, though challenges remain in ensuring a reliable supply.

Biomass
Still used for cooking in rural areas, but traditional biomass is harmful. Modern solutions are under exploration but not yet scaled.

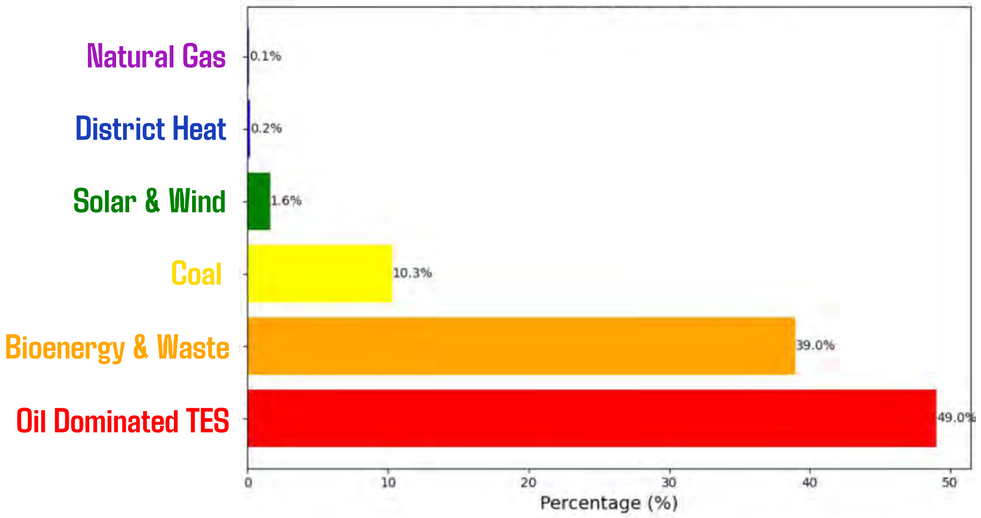
NUCLEAR POWER

Nuclear Power
Not part of Senegal's strategy due to high costs, safety concerns, and lack of infrastructure. Unlikely in the near term.

ENERGY STATE OF SENEGAL

Senegal

ENERGY SUPPLY BREAKDOWN



ACCESS TO ELECTRICITY
(% of population with access)
Year : 2022

ACCESS TO CLEAN COOKING
(% of Population with access)
Year : 2022

RENEWABLE ENERGY
(% of Total Final Energy Consumption)
Year : 2021

ENERGY EFFICIENCY
(MJ per USD 2017 PPP)
Year : 2021

Country Value
3.6
4.6
Global Average

RENEWABLE CAPACITY PER CAPITA
(Watts per capita)
Year : 2022

26

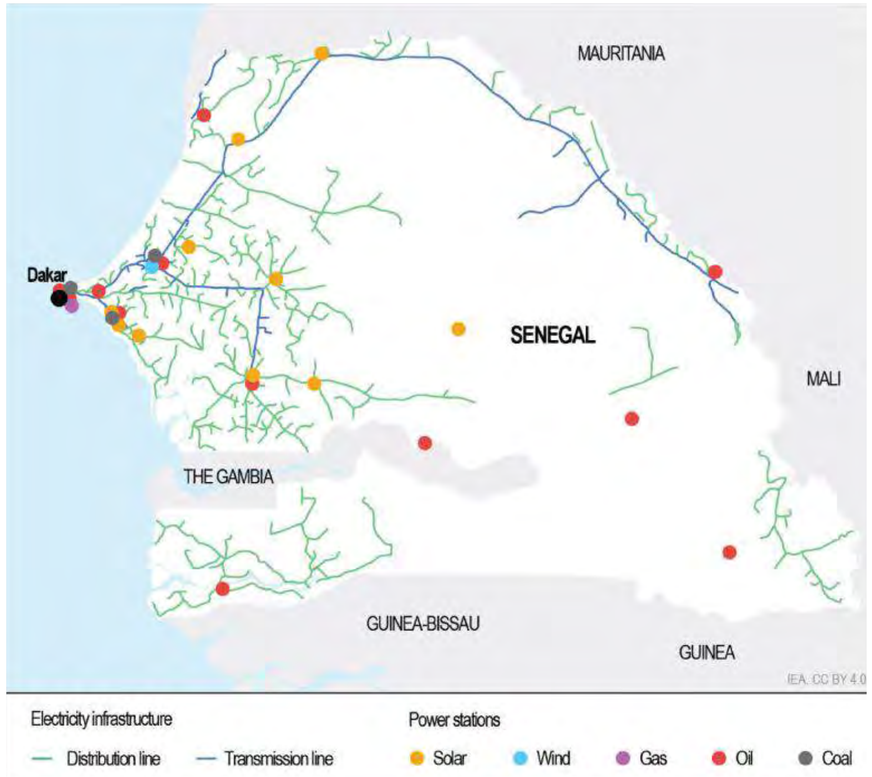
INTERNATIONAL FINANCIAL FLOWS
(USD million, 2021 PPP)
Year : 2022

88.4

ELECTRICITY INFRASTRUCTURE OF SENEGAL

ENERGYNEXUS

ELECTRICITY INFRASTRUCTURE AND POWER PLANTS IN SENEGAL



Adapted from IEA 2023 Senegal Energy Overview

POWER PLANTS IN SENEGAL BY SOURCE:

SOURCE	OUTPUT	COUNT
Oil	889 MW	12
Solar	242 MW	15
Wind	159 MW	1
Coal	115 MW	1
Diesel	14.00 MW	1
Gas		1
Unspecified		9
All	1,418 MW	40

40 Power plants Provide 1418 MW and is supplied through 1371 Km of power lines .

POWER LINES IN SENEGAL BY VOLTAGE:

VOLTAGE	LENGTH	PERCENTAGE
0-9 KV	0 m	0 %
10-24 KV	0 m	0 %
25-51 KV	0 m	0 %
52-131 KV	191 km	13.9 %
132-219 KV	0 m	0 %
220-329 KV	875 km	63.9%
330-549 KV	0 m	0 %
550 KV -	0 m	0 %
No Voltage Tagged	305 km	22.2 %
TOTAL	1371 km	100 %

CURRENT SCENARIO V/S VISION 2030

ENERGYNEXUS

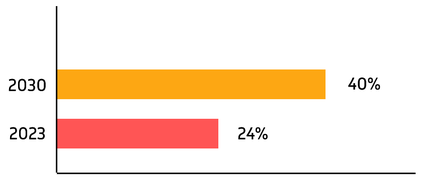
SHARE OF RENEWABLES IN CARBONISED POWER SYSTEM

FUTURE EXPECTATIONS

40% of renewables in the power capacity by 2030.

CURRENT SENARIO

Currently 24% of renewables account for the power capacity.



PERCENT OF RENEWABLES IN POWER CAPACITY

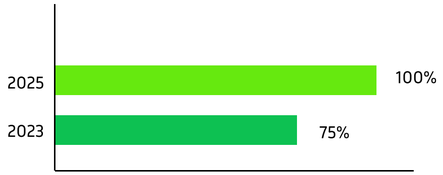
ACCESS TO ELECTRICITY

FUTURE EXPECTATIONS

The country targets universal access to electricity by 2025

CURRENT SENARIO

75% households access to electricity



PERCENT OF ACCESS TO ELECTRICITY

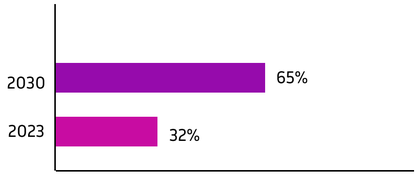
ACCESS TO CLEAN COOKING FUELS

FUTURE EXPECTATIONS

According to the NDCs ,Senegal's target is to have 65% of households using clean cooking technologies by 2030

CURRENT SENARIO

32 % households access to clean cooking fuels



PERCENT ACCESS TO CLEAN COOKING FUELS

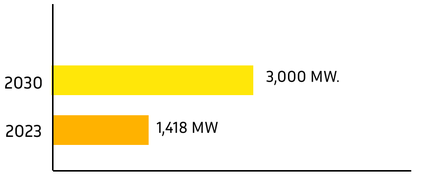
ELECTRICITY PROVISION CAPACITY

FUTURE EXPECTATIONS

Senegal's total electricity generation capacity target by 2030 is approximately 3,000 MW

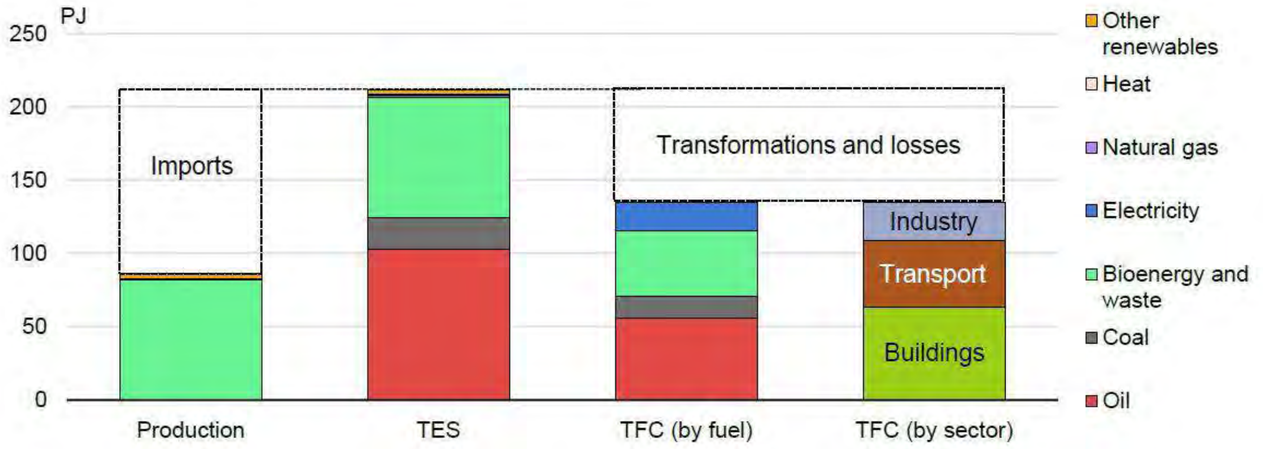
CURRENT SENARIO

Currently its generation capacity stands at around 1,418 MW



GENERATION CAPACITY

1. UNSUSTAINABLE ENERGY & CARBONISED POWER SYSTEM



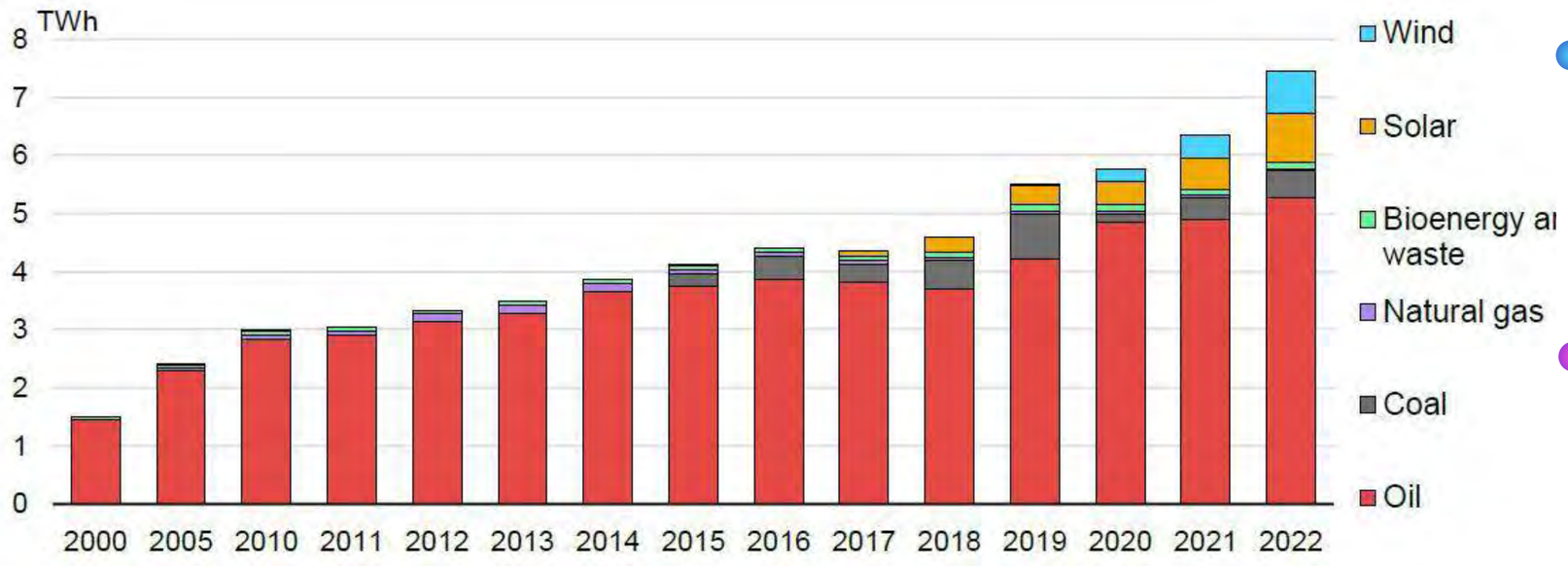
OVERVIEW OF ENERGY PRODUCTION, SUPPLY AND DEMAND IN SENEGAL

- Currently, 59% of energy is produced from imported fossil fuels (10% from coal and 49% from oil). As demand grows, this reliance is becoming increasingly unsustainable, both environmentally and economically.
- The reliance on imported fossil fuels has made energy costs in the country increasingly unaffordable.
- Additionally, significant transmission losses are contributing to an increasingly unaffordable and unsustainable energy supply in the country.

SENGAL PRIMARY ENERGY DEMAND AND GDP IN THE STATED POLICIES SCENARIO, 2010-2040

ISSUE ANALYSIS

1. UNSUSTAINABLE ENERGY & CARBONISED POWER SYSTEM



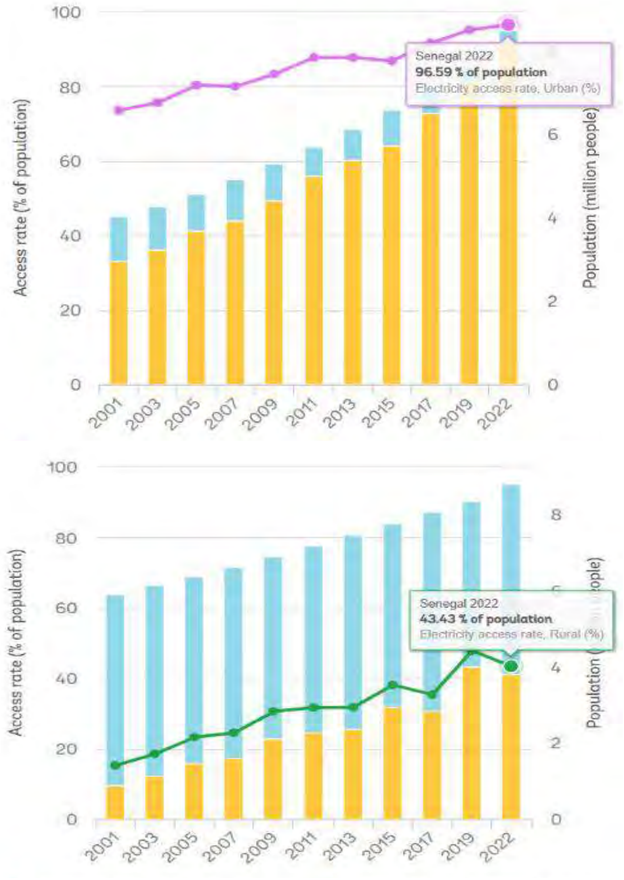
ELECTRICITY GENERATION BY SOURCE IN SENEGAL, 2000-2022

- Each year, energy demand continues to rise, and heavy fuel oil (HFO) remains the primary source of electricity generation in Senegal, comprising 70% of the total in 2022.
- This creates an overreliance on a single source of electricity, making the energy supply less reliable. Diversifying the energy mix for electricity generation is essential.

- This reliance also results in significant environmental impacts due to high carbon emissions from fossil fuel combustion. Therefore, a transition to renewable energy is urgently needed.

ISSUE ANALYSIS

2. INACCESIBLE, UNAFFORDABLE & UNRELIABLE ELECTRICITY



ELECTRICITY INACCESSIBILITY

There is very strong disparities among Urban and Rural.

In 2022, around 4 million people living in rural areas still lacked access to electricity services.

- Electricity Access Rate (Urban)
- Electricity Access Rate (Rural)
- Population with access to electricity (million people)
- Population without access to electricity (million people)

UNAFFORDABLE ELECTRICITY

Approximately $36 of the $300 monthly income, or around 12%, is spent on electricity, exceeding the nfcc standard guideline that energy costs should not surpass 6-8% of household income.

UNRELIABLE ELECTRICITY

Senegal's electricity is unreliable due to dependence on imported oil, outdated infrastructure, transmission losses, and limited rural access. Low renewable integration and frequent equipment failures further impact stability across the country.

SENEGAL

Average Family Income Monthly

300 USD *2022

Average Consumption to Cost per Family

150 UNITS per Month
x 0.24 USD per unit

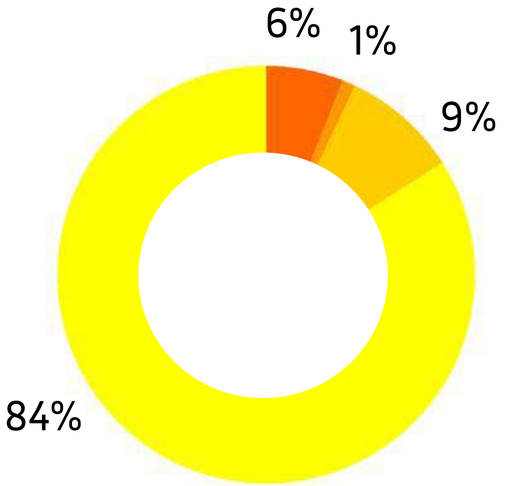
~ 36 USD per Month

ISSUE ANALYSIS

3. COOKING FUEL CRISIS

ENERGYNEXUS

BIOMASS % COAL % ELECTRICITY % LPG BIOGAS % KEROSENE %



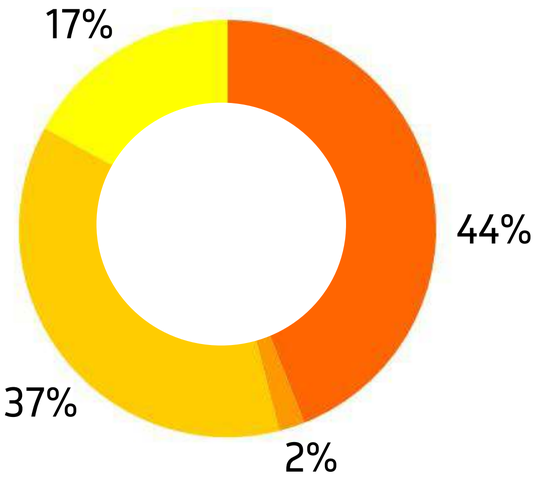
Almost 12 million of the Senegalese population still rely on traditional biomass such as firewood and charcoal

LPG usage has increased by 77% during the past decade (173,000t* domestic lpg consumption)

It is estimated that emissions from residential cooking fuels contribute approximately 4-5 million tons of CO2 annually in Senegal

Region: SENEGAL
Area : **RURAL**

Region: SENEGAL
Area : **URBAN**



COOKING FUEL HEALTH IMPACT

Lower respiratory infections account for almost 15% of household air pollution related deaths.

12,600 people die annually due to exposure to household air pollution, primarily from using solid fuels like wood, charcoal, and kerosene.

Cooking-related accidents, including burns and poisoning, are a common health hazard due to the unsafe use of these fuels.

*2022-WLPGA statistics, IRENA **WHO

SOLUTION

1. UNSUSTAINABLE ENERGY & CARBONISED POWER SYSTEM

SOLUTION

COMPARITITIVE ANALYSIS OF DIFFERENT ENERGY ALTERNATIVES

ENERGYNEXUS

- Here, we try to solve the unsustainable energy challenge by bringing more renewable energies into the original mix.
- Our proposal includes using solar, wind and natural gas.

WHY REJECT HYDROPOWER?

- High Initial costs
- Affects the river ecosystem and the rivers are shallow

WHY REJECT NUCLEAR ENERGY?

- Senegal does not have enough infrastructure or resources
- Could cause political disturbances

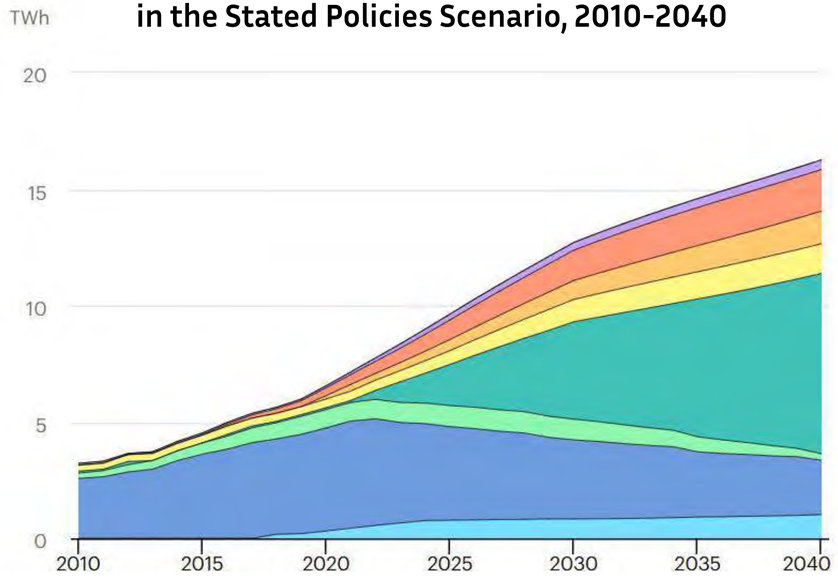
SOURCE	WIND ENERGY	SOLAR ENERGY	NATURAL GAS	HYDROPOWER	NUCLEAR ENERGY
INITIAL COST	High initial cost for infrastructure but declining with technology improvements.	Moderate to high, but rapidly decreasing with economies of scale.	High for extraction and infrastructure, but competitive for large-scale projects	High due to dam construction and geographic limitations	Extremely high due to complex safety and regulatory requirements.
RESOURCES AVAILABLE	Strong coastal and wind potential (5-7 m/s).	High solar radtations(5.5-6 kWh/m^2/day)	Large offshore reserves(Grand Tortue)	Limited potential	No uranium resources or infrastructure
ENVIORNMENTAL IMPACT	Low emissions; minor impact on wildlife and noise	Low emissions; land use and panel production concerns	Moderate emissions; concerns with flaring and leaks	Low emissions, but affects river ecosystems.	Low emissions, but high accident risk and waste issues.
FEASIBILITY	Moderate (developing infrastructure	High (suitable for rural areas)	Moderate (Dependent on IOC's)	Low (few suitable sites)	High (good coastal potential)

SOLUTION

NATURAL GAS: IMMEDIATE RELIEF FOR SENEGAL'S ENERGY CRISIS

ENERGYNEXUS

Senegal electricity generation by technology in the Stated Policies Scenario, 2010-2040



NATURAL GAS

CURRENT: 0.4%

TARGET BY 2034: 20%

OIL

CURRENT: 70%

TARGET BY 2034: 35%

OUR PROPOSED SOLUTION

- Setting up 400 MW natural gas powerplant
- Natural Gas as an emerging power source to reduce dependency on expensive imported oil.
- Replacing HFO with natural gas could reduce over 2 million tonnes of CO2 annually, significantly lowering Senegal's carbon footprint.

We are proposing Natural gas as a "bridge" fuel in the transition from coal or oil-based energy systems to cleaner energy sources like renewables.

Senegals LNG Projects under development*

The domestic production of gas will come from the gas fields of GTA, Yakaar-Teranga and Sangomar.

With the LNG production on GTA, the country is expected to be an exporter from 2024 onwards.

*Senegal's Gas-to-Power Ambitions: Securing Scale and Sustainability PAPA DAOUDA DIENE, THOMAS SCURFIELD, AARON SAYNE AND JESSICA OBEID JUNE 2024

SOLUTION

SOLAR AND WIND: POWERING SENEGAL'S SUSTAINABLE FUTURE

ENERGYNEXUS

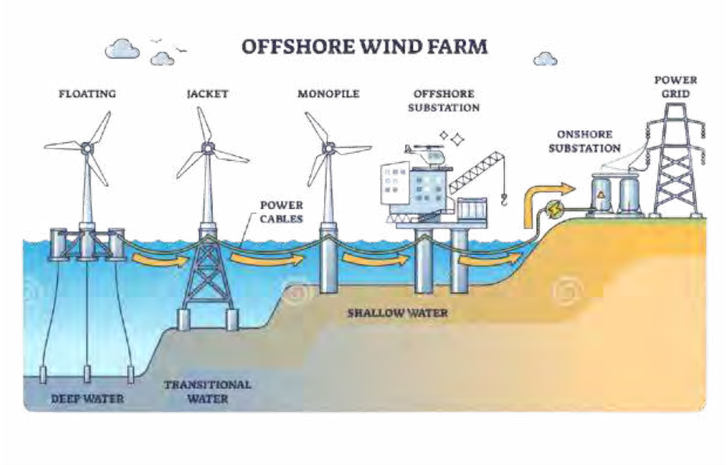
WIND ENERGY

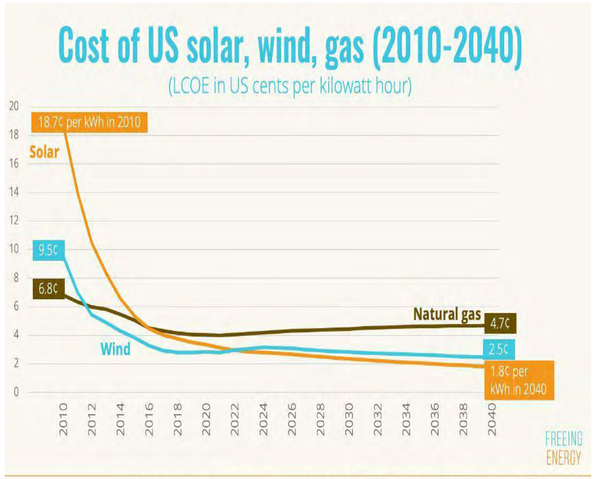
Senegal's coastal regions, especially Taïba N'Diaye, experience consistent wind speeds of 4-6 m/s, making them perfect for wind energy!

The Taïba N'Diaye wind farm's 158 MW output proves wind energy's viability. Setting up wind farm in partnership with IPPSs focusing on coastal and offshore areas with strong winds.

+ 100 MW

5% → 8%
CURRENT BY 2034
% OF TOTAL ENERGY MIX





SOLAR ENERGY

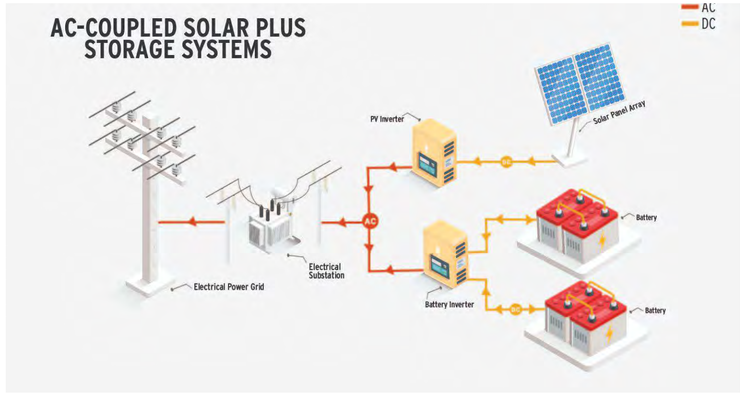
Senegal has abundant renewable resources and one of the world's highest solar irradiation potentials, averaging 5.798 kWh/m² daily.

Senegal's solar parks, like Bokhol and Malicounda, have already surpassed the 2030 solar PV target as of 2022.

Consequently, many IPPs are eager to invest in solar energy. We plan to provide PPAs and grid-connected solar projects and connect it with BESS.

+ 300 MW

10% → 20%
CURRENT BY 2034
% OF TOTAL ENERGY MIX



IEA Energy Overview Policy 2023: Senegal, https://www.iea.org/reports/senegal-2023

SOLUTION

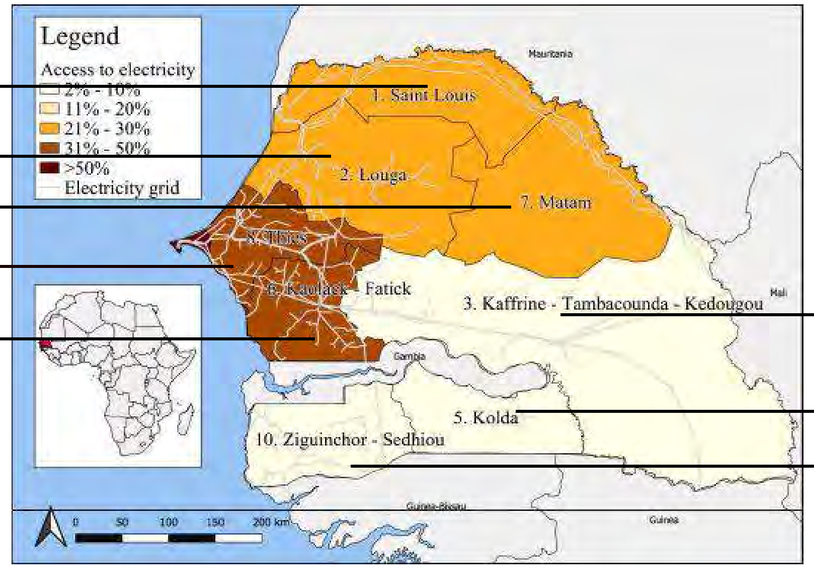
2. INACCESIBLE, UNAFFORDABLE & UNRELIABLE ELECTRICITY

SOLUTION

OUR PROPOSITION

ON GRID LOCATIONS

1. Thies
2. Kaolack-Fatick
3. Louga
4. Saint Louis
5. Matam



Adapted from IEA Energy Overview Policy 2023

OFF GRID LOCATIONS

1. Kaffrine-Tambacounda-Kedougou
2. Kolda
3. Ziguinchor-Sedhiou

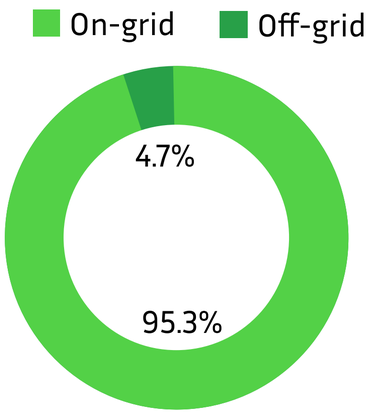
SOLUTION

2A.ON GRID SOLUTION

ON-GRID INNOVATION: POWERING A MORE EFFICIENT SENEGAL

ENERGYNEXUS

ON-GRID SOLUTION



SENEGAL's on grid and off grid distribution

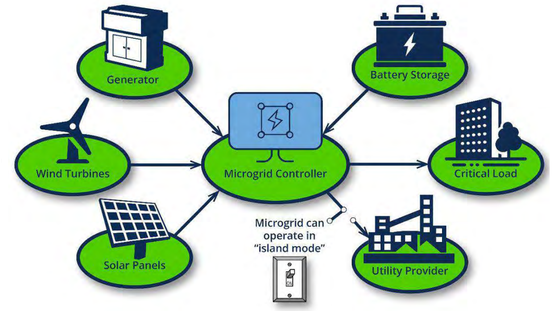
CHALLENGES FACED

Only 95% of the total households are able to obtain electricity by grid system

Imported fossil fuels drive electricity costs up to $0.233/kWh.

Huge transmission losses of almost 14.6% cause huge wastage of power

OUR PROPOSITION



Smart Grid
- better management of resources
- reduction in transmission losses
- drive costs down

Single Wire Earth Return (SWER) Network
- Very cost effective
- Drives grid expansion

BESS Incorporation
- Store excess renewable energy
- Reduce gas plant dependency
- Reduce power outage duration

100 GWh / YEAR
OF LOSSES WILL BE REDUCED

95% → **99%****
CURRENT BY 2034
ON GRID PERCENTAGE

53 min → **15** min
CURRENT BY 2034
TIME DURATION PER POWER OUTAGE

**POWER GENERATION AND TRANSMISSION MASTER PLAN FOR SENEGAL

ON-GRID: IMPLEMENTATION PLAN

ENERGYNEXUS

2025-2026: Feasibility Study

Feasibility Study:
Identify priority regions for SWER and BESS in peri-urban areas, mapping viability based on infrastructure, terrain, and proximity to solar/wind grids.
Funds Procurement & Regulatory Approval:
Secure permits, licenses, and supplier agreements, collaborating with locals and international partners like the World Bank.

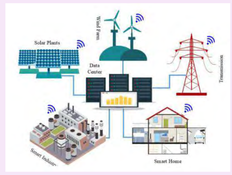
1% Target achieved
successfully connected 5000 households

2027-2028: Pilot Program

SWER:
Test **35000** SWER connections for reliable energy in remote areas.

Smart-Grid:
Equip **10%** of the grid with smart technologies for monitoring and demand management.

BESS:
Deploy BESS at a **15MW** solar/wind farm to manage peak load.

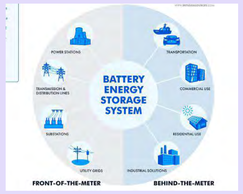


16.6% Target achieved
successfully connected 80,000 households

2029-2030: Initial Rollout

SWER Expansion:
Add 65,000 connections, focusing on agriculture to boost productivity.

Smart-Grid Expansion
Extend smart-grid to 30% of the grid by installing smart meters and using data analytics in urban areas.
BESS Integration:
Integrate BESS with solar power plants.



38.1% Target achieved
successfully connected 190,000 households

2031-2034: Full Scale-Up

Expand SWER
for full electrification of remote areas, targeting **1.5** lakh homes.

Deploy smart-grid:
controls to **60%** of the grid with smart meters and real-time analytics to cut energy losses

Boost renewable integration
by adding 110MWh BESS capacity to existing wind and solar farms.

100% Target achieved!
successfully connected 390,000 households

All projections are based on report given on greenminigrid.afdb.org (a pdf on the electrification of Senegal)

SOLUTION

2B.OFF GRID SOLUTION
LIGHTING LIVES, LIGHTING HOMES

PROBLEM IDENTIFICATION & SOLUTION

ENERGYNEXUS

OFF GRID SOLUTION

CHALLENGES FACED

Little to no accessibility: Rural Senegal has only 55% electricity access.

Investor Concern: Investors fear grid expansion will reduce demand for off-grid solutions.

Unskilled Labor: Untrained workers struggle to maintain off-grid systems.

OUR GOAL IS TO PROVIDE

Providing Youth Employment

Government Support for Renewable Energy Expansion

Private Sector Partnerships in Renewable Energy

Clean Energy for Better Health

Lighting Lives in senegal

OUR PROPOSITION

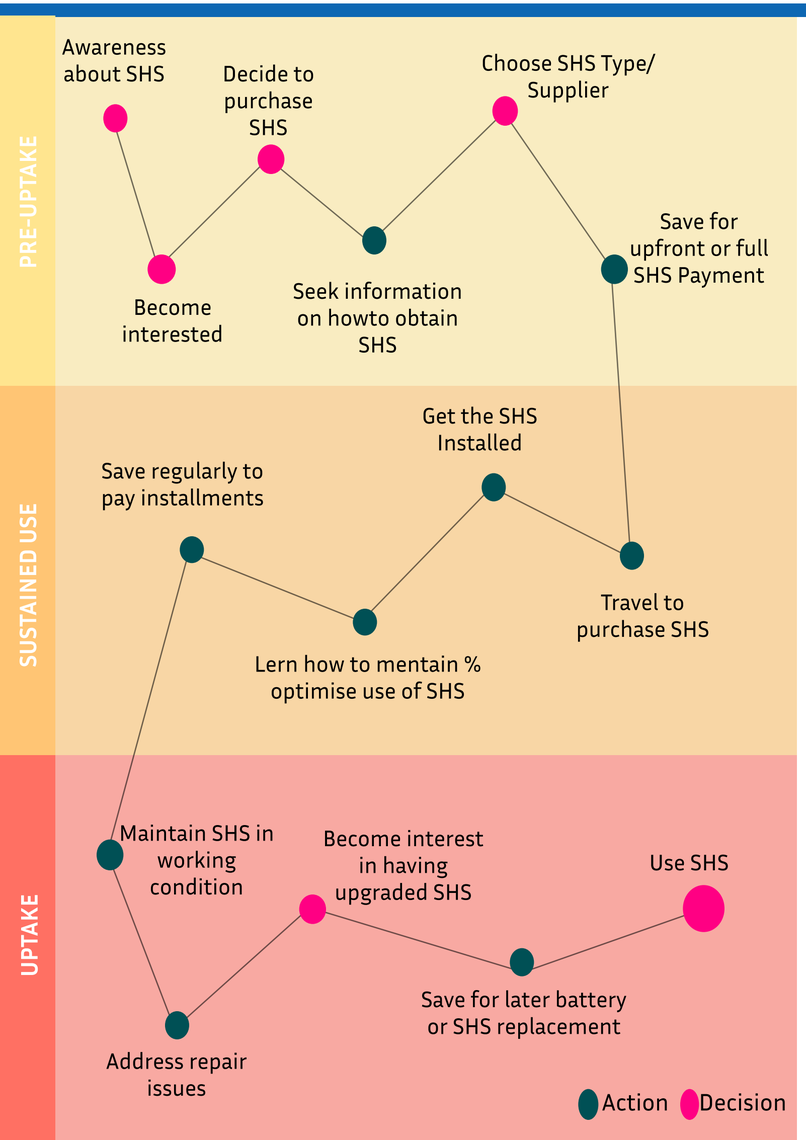
Solar Minigrids
Deploy solar minigrids via EaaS(Energy as Service) for remote energy access without grid strain.

Solar Home Systems (SHS)
In remote areas for affordable basic electrification of low-consumption households.

Community Outreach
- Train and upskill workers
- Build trust in solar off grid.
- Incentivise investors
- Flexible Financial Options

SOLAR HOME SYSTEMS: POWERING AFFORDABLE ACCESS

ENERGYNEXUS



SOLAR HOME SYSTEM-OUR PROPOSITION

Simplified Awareness Campaigns: Highlight solar home benefits with a slogan like "Brighten Your Ramadan with Solar" and provide supplier contacts for easy access.

Door-to-Door Initiative:
Company reps visit homes to educate residents on saving and earning with Solar Home Systems (SHS), sharing government grants and user testimonials.

Solar "Ambassadors": Leverage peer trust by training local solar ambassadors in SHS maintenance and rewarding them with community recognition.

Accountability Help: solar savings box, calendar, and alerts with biweekly meetings led by the solar ambassador to ensure saving accountability.

Phone expense tracker: encouraging energy expense tracking to estimate potential savings

Repair and Maintenance Service:
Establish a free service system for quick response to repair and maintenance needs, prioritizing efficiency and ensuring timely customer assistance.

WILLING-TO-PAY ANALYSIS

WITHOUT SHS

Dry cell Battery : $ 9 / month
Mobile charging cost : $5.35 - $10.7 / month
(Assuming charging once per day)
Travel : On average 5-20 Km : $0.9* month

TOTAL : **$27.35 - $33.2**

WITH SHS  **V/S** **WITHOUT SHS** 

WITH SHS

Installation costs : $10*
(Original cost is $17.9)
Monthly installments : $ 10.22

TOTAL : **First Month :** **$20.22**
Later on : **$10.22**

Purchase upfront, or on credit for 18-24 months, after which the consumer becomes owner of the SHS.

Adapted from Senegal Rural Electrification Program Behavioral Diagnostics from worldbank.org

IMPLEMENTATION PLAN

ENERGYNEXUS

2025-2026: Expanding Mobile Money for Solar

- Study remote areas, limited mini-grid access Launch awareness campaigns for Solar Home Systems (SHS)
- Set strict service and maintenance standards for SHS quality
- Divide target areas into regions and issue separate tenders for each

2027-2028: SHS Adoption Plan

- Finalize tenders and offer company incentives
- Promote door-to-door initiatives
- Provide grants for buyers
- Assign Solar Ambassadors from the community to encourage SHS adoption
- Deploy 20,000 SHS units annually to pilot test

Solar home systems : 40000

2029-2031: Accelerate Solar Home Systems and Mini-Grids

- Deploy further 30,000 SHS units annually in high-need regions
- Collect feedback to refine policies
- Push companies to establish multiple repair stations
- Partner with telecom providers to expand mobile money access in rural areas

Solar home systems : 130000

2032-2034: Full Scale-Up

- -Deploy 40,000 SHS units annually
- Introduce a phone-based expense tracker
- Set up accountability centers to assist with saving for monthly installments

Solar home systems : 250000

COMPANY INCENTIVES :

- Remove VAT tax on their products
- Reduce import taxes
- Lower interest rates on loans
- Guarantee no grid expansion until a set year to reduce uncertainty

PEOPLE'S INCENTIVES :

- PAY-as-you go system.
- Subsidized installation
- Provide free maintain services

Potential donors for SHS

Schneider Electric

BAOBAB+

LAGAZEL

ilemel Energy Solutions

VITALITE SENEGAL

ElleSolaire WOMEN'S ENTREPRENEURSHIP INITIATIVE

All projections estimated from from Senegal Rural Electrification Program Behavioral Diagnostics from worldbank.org

ROADMAP FOR MINI-GRID IMPLEMENTATION

ENERGYNEXUS

2025-2026: Planning

- Identify high-density villages with no grid expansion planned for 10 years.
- Issue attractive tenders for companies to operate mini-grids.

2027-2028: Pilot & Incentive

- Finalize tenders, license companies, and harmonize tariffs.
- Deploy the first mini-grid for pilot testing.
- Train locals and raise awareness.

Minigrids Deployed : 1
Capacity : 50 kW

2029-2030: Scale

- Offer subsidized electricity rates.
- Deploy 35 mini-grids annually and gauge community response.
- Educate communities on mini-grid adoption.

Minigrids Deployed : 72
Capacity : 2250 kW

2031-2032: Rapid expansion

- Deploy 65 mini-grids annually and assess performance.
- Install meters for strict monitoring.
- Keep tariffs low and encourage grid intensification.

Minigrids Deployed : 202
Capacity : 7500 kW

2033-2034: Making it sustainable

- Complete Deployment of 100 mini-grids yearly.
- Increase local engagement for solar adoption.
- Re-evaluate success for expansion.

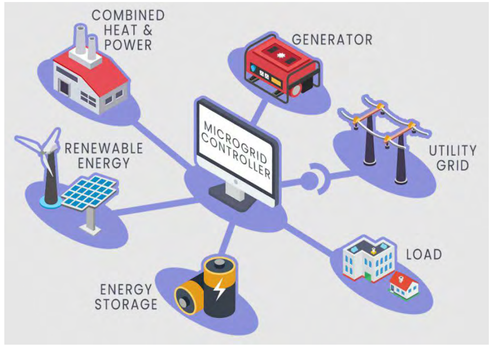
Minigrids Deployed : 402
Capacity : 10000 kW

KEY FEATURES :

Grant 10-year licenses with compensation and new contracts if grid expands to licensed areas.

Implement monitoring and metering for sustained usage.

Set rates at $0.15/kWh instead of $0.223/kWh and promote public awareness for opt-in.



Issues contributing to the unsustainability of O&M include non cost-reflective tariffs, under-sizing of the grid, and lack of metering and monitoring.

PROJECTED GOAL :

Each Minigrid connects : ~ 200 households

No of people connected : ~800,000 rural people

SOLUTION

3. SOLUTION FOR COOKING FUEL SCENARIO

3A.URBAN

SOLUTION FOR COOKING FUEL SCENARIO

ALTERNATIVES IN URBAN

ENERGYNEXUS

TYPE OF STOVE	BIOETHANOL STOVE	LPG STOVE	ELECTRIC STOVE
TYPE OF FUEL	BIOETAHNOL	LPG	ELECTRICITY
ACCESSIBILITY	Denatured bio-ethanol for cooking is only available from a few emerging providers	LPG is widely available, with 36% using it as primary fuel and 60% having LPG stoves in urban areas.	Limited availability High initial capital investment required
COST OF RESOURCES REQUIRED	**STOVE** : $25 to $50 per unit **FUEL**: $1.50 to $2.00 per liter	**STOVE** : $50 to $150 per unit **FUEL**: $0.15 to $0.20 per kWh	**STOVE** : $30 to $100 per unit **FUEL**: $1.00 to $1.50 per kg
EFFICIENCY	40% to 60%	50% to 70%	80% to 90%
HEALTH HAZARD	Air pollution due to incomplete combustion.	Very limited combustion emission	Very negligible amount of combustion.

Presents itself as the most cost efficient,accessible and scalable solution

SOLUTION FOR COOKING FUEL SCENARIO

ACTION PLAN FOR URBAN

ENERGYNEXUS

- Study to improve efficiency of LPG terminals at Dakar and Sendou-Bargny by 2025.
- Introduce competitive tendering for LPG storage, backed by Minimum Purchase Agreements and Long-term Supply Contracts.
- Identify urban areas reliant on charcoal and firewood.

Phase 1 2025-2026

- Launch IoT-based pay-as-you-go LPG system.
- Renovate Dakar port, optimize Sendou-Bargny for better LPG distribution
- Establish 10 LPG filling plants in key urban areas.
- Optimize the LPG fleet with eco-friendly vehicles.

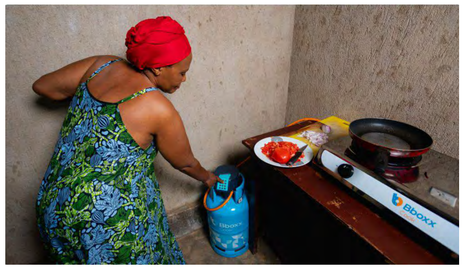
Phase 2 2027-2028

Phase 3 2029-2031

- Offer installment-based LPG connections, free stoves, and loyalty programs.
- Engage charcoal sellers to promote LPG with incentives.
- Run community awareness programs on health risks of charcoal and firewood.

Phase 4 2032-2034

- Track LPG adoption, extend services to peri-urban areas.
- Explore transition to clean electricity and renewables.
- Monitor LPG adoption and adjust strategies using consumption data.



Pay-as-you-go liquefied petroleum gas supports sustainable clean cooking in Kenyan informal urban settlement during COVID-19 lockdown, Applied Energy,

SOLUTION FOR COOKING FUEL SCENARIO

ACTION PLAN FOR URBAN

ENERGYNEXUS

OUR VALUE CHAIN AND IDENTIFIED PAIN POINTS

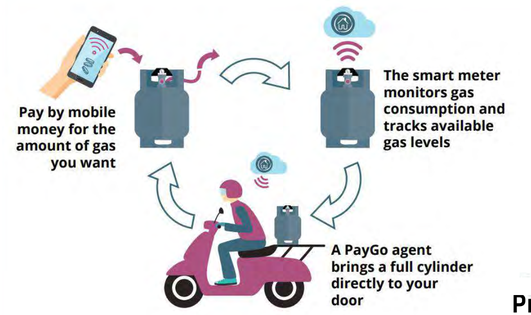
	Insufficient to handle increasing demands	inaccessible to peri-urban Manual inventory management	Carbonised Fleet Lost cylinders in value chain	Lack of customer & cylinder data	Customers are afraid of running out of gas
	Storage setup for stratergic locations	Storage at strategic locations IoT based tracking	Carbonised Fleet IoT based tracking	Smart metering device	Prepayments as per usage Pay as u go model

KEY FEATURES OF PAY-AS-YOU-GO SYSTEM

Energy is prepaid in small, affordable increments

Offer customers the option to expand capacity

Easy Installation, simple mechanism, affortable, convenient.



Projected number of LPG households for each year based on an 8.1% annual growth rate

SOLUTION FOR COOKING FUEL SCENARIO

BEYOND 2034

ENERGYNEXUS

TRANSITIONING TO CLEAN ELECTRIC STOVE POST-LPG ADOPTION

LEVERAGE LPG SUCCESS:

After a decade of LPG adoption, use the infrastructure and community engagement built during the program to smoothly transition to clean electricity, particularly among higher-income urban households

LPG STOVES

ELECTRIC STOVES

NATIONAL IMPACT AWARENESS:

Inspire households by highlighting how transitioning to electric stoves empowers them to drive Senegal's energy independence, reduce reliance on imported oil, and play a pivotal role in the nation's sustainable future

RENEWABLE ENERGY INTERGRATION:

Raise public awareness about available renewable energy options, such as solar and wind power, and promote the benefits of energy efficiency.

SOLUTION

3.SOLUTION FOR COOKING FUEL SCENARIO

3B.RURAL

CURRENT COOKING FUEL SENARIO

RURAL SENEGAL

ENERGYNEXUS

COOKING METHOD	IMAGE DESCRIPTION	DESCRIPTION	EFFICIENCY	ISSUES
TRADITIONAL WOOD STOVE		Basic open-fire stoves using firewood	**LOW** often around 10-20%	• High fuel consumption • Smoke emissions • Health risks from indoor air pollution
TRADITIONAL CHARCOAL STOVE		Use charcoal as a fuel source, often in simple metal or clay stoves	**MODERATE** often around 15-25%	• Charcoal production contributes to deforestation • Smoke emissions are still a concern
3 STONE FIRE		A traditional method using three stones to support cooking pots over an open flame	**VERY LOW** often <10%	• Inefficient use of fuel • High smoke emissions • Safety hazards

POSSIBLE SOLUTION IDENTIFICATION
RURAL SENEGAL

ENERGYNEXUS

WHY TAARU?

Taaru is a metal charcoal stove with a moveable combustion chamber that can be changed at any time. The skirt of the stove consists of two cones that improve air circulation for better combustion.

WHY TAARU?

Charcoal is significantly more accessible than firewood and burns longer than other fuels in rural Senegal.

TAARU's affordability makes it an ideal solution for rural Senegal, balancing both environmental impact and cost.

Solutions like Rocket stoves are often impractical in rural Senegal due to their prohibitively high costs.

OUR PROPOSED SOLUTION

Taaru

Fuel: Charcoal

Av. Reduction of specific fuel consumption against most common baseline stove (Efficiency: 45 – 50%)

Average price: USD 9

Rocket Institutional

Fuel: Firewood

Av. Reduction of specific fuel consumption against most common baseline stove (Efficiency: 45 – 50%)

Average price: USD 92

Banco Household and institutional

Fuel: Firewood

Av. Reduction of specific fuel consumption against most common baseline stove (Efficiency: 50 – 60%)

Average price: USD 5

BETTER ALTERNATIVE TECHNOLOGIES AVAILABLE

TOPPING UP THE SOLUTION WITH TYPHA CHARCOAL

Typha is a plant that has been significantly hindering agricultural productivity in senegal since last 30 years.

Seasonal Typha can be converted into charcoal, addressing agricultural challenges while offering a sustainable cooking fuel.

Cost of Production: Approximately : $25 to $50 per ton.

Yield: About 200 to 300 kg of charcoal from 1 ton of Typha.

Why not Banco?

Due to the scarcity of firewood in rural Senegal.

ACTION PLAN
RURAL SENEGAL

ENERGYNEXUS

Phase 1
2025-26

- Conduct surveys to assess cooking habits and openness to clean cooking solutions.
- Assess feasibility in areas with widespread traditional cookstoves.
- Build partnerships with NGOs and the government to promote clean cookstoves.

Phase 2
2027-28

- Set up 7 fabrication plants
- Provide performance-based financing and training to local artisans.
- Engage women's groups for financing via tontine structures in 8,000 villages.

Phase 3
2029-31

- Training distributors in improved cookstove handling.
- Expand Last-Mile Entrepreneurs (LMEs) with starter kits and distribution tools.

Phase 4
2032-34

- Implement a framework for quality assurance and transparent labeling.
- Monitor market adoption and impact.
- Promote biogas as a cleaner alternative for long-term ICS users.

ADVANCED TAARU STOVE IMPLIMENTATION

ACTION PLAN FOR RURAL

Proposed locations for TAARU Stove Fabrication plants

Adopted from Promotion Climate Friendly Cooking Kenya and Senegal

OUR GOAL

Reduce deaths and illness due to indoor pollution especially women and girls

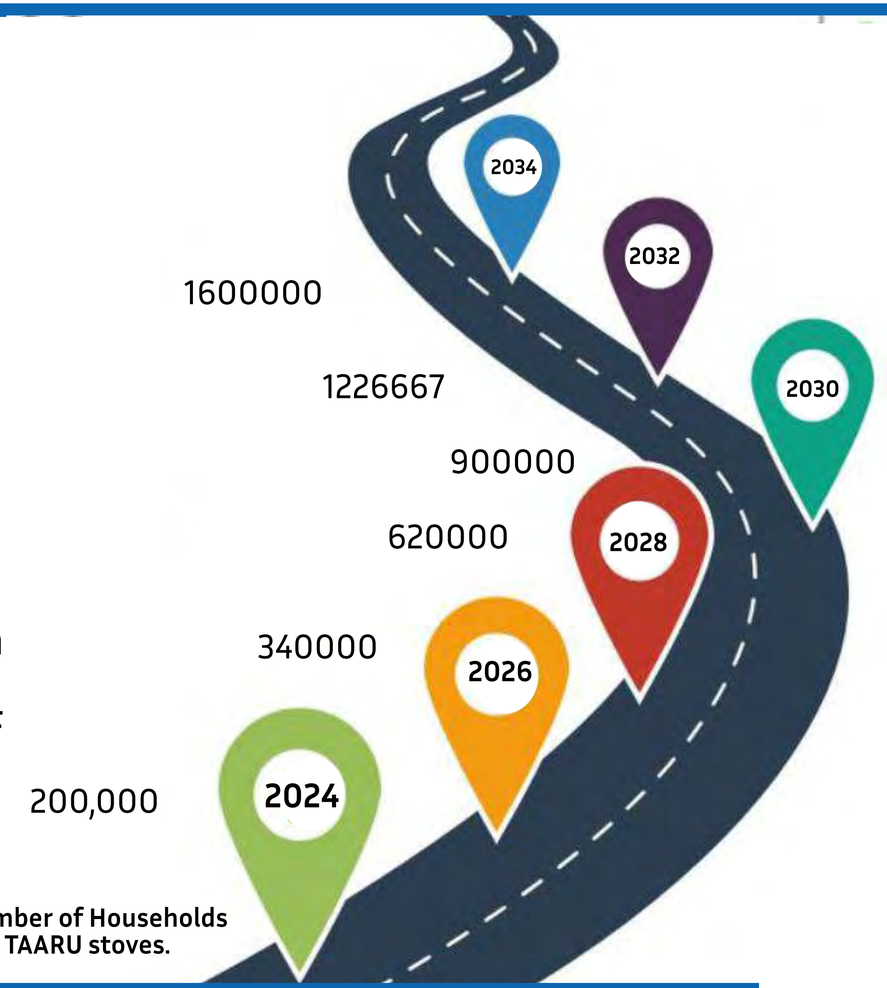
Reduce Carbon Footprint

Minimize Cooking-Related Illnesses

Create Job Opportunities

WILLINGNESS TO PAY

About 85% of the population can buy an improved cookstove (ICS) for 3,000 XOF. An ICS costing 3,900 to 6,000 XOF reduces fuel consumption by 40%, saving 1,950 XOF monthly and allowing recovery in 2-3 months



Projected number of Households adopting TAARU stoves.

Projected number of TAARU adopting households for each year based on an ~20% annual growth rate

SOLUTION FOR COOKING FUEL SCENARIO

BEYOND 2034

ENERGYNEXUS

TRANSITIONING TO BIO-GAS POST UNIVERSAL ICS ADOPTION

Biogas Potential and Current Challenges

Following the success of Senegal's 10-year strategy on improved cookstoves (ICS), which introduced cleaner cooking alternatives to rural communities, the country is now poised to transition further into biogas. Biogas production holds great potential for clean energy, but socio-economic and technical challenges persist. The National Biogas Programme (PNB-SN) was designed to expand energy access and reduce environmental impacts, yet progress has been slow. Poorly implemented policies have limited effectiveness, with fewer than 600 biodigesters installed out of an 8,000-unit target.

Building on ICS Success to Foster Biogas Adoption

The 10-year ICS program has laid the groundwork by raising awareness and familiarizing communities with clean cooking technologies. This success serves as a critical foundation for introducing biogas, as rural populations are now more receptive to alternative energy solutions beyond firewood and charcoal. Improved cookstoves have increased demand for cleaner energy options, creating a smoother pathway for biogas adoption.

Roadmap for Effective Biogas Transition

Targeted Awareness Campaigns: Launch initiatives to educate communities about biogas benefits, leveraging the success of the ICS program to build trust and interest.

Policy and Infrastructure Enhancement: Improve policies and infrastructure to support widespread installation and maintenance of biodigesters.

Long-term Rural Integration: Address socio-economic barriers and ensure sustainable access to biogas, enhancing energy security, health, and environmental outcomes in rural areas

FINANCIAL PLAN

ELECTRICITY BUDGET

ENERGYNEXUS

GRID INTENSIFICATION BUDGET — $ 175,000,000

PHASE	NO.OF CONNECTIONS	ESTIMATED COSTS
PILOT PROGRAM	5000	$ 2,500,000
INITIAL ROLLOUT	30000	$ 15,000,000
COMPLETE DEPLOYMENT	315000	$ 157,500,000
TOTAL ESTIMATED COSTS		$ 175,000,000

BESS BUDGET (200 KW CAPACITY) — $ 111,426,700

COMPONENT	COST PER KWh ($)	ESTIMATED COSTS
BATTERY (LITHIUM IRON PHOSPHATE)	$ 299	$ 59,800,000
INVERTER AND POWER ELECTRONICS	$ 100	$ 20,000,000
BALANCE OF SYSTEM (WIRING,ENCLOSURE ETC)	$ 100	$ 20,000,000
INSTALLATION (10%)		$ 9,980,000
TOTAL CAPEX		$ 109,780,000
ANNUAL O&M COSTS(1.5% OF CAPEX)		$ 1,646,700
TOTAL ESTIMATED COSTS		$ 111,426,700

SMART GRID BUDGET — $ 58,580,000

COMPONENT	COST /UNIT ($)	ESTIMATED COSTS
SMART METERS	$ 70	$21,000,000
DISTRIBUTION AUTOMATION	$ 200,000	$ 20,000,000
REAL-TIME MONITORING SENSIORS	$ 1000	$ 10,000,000
DISTRIBUTION MANAGEMENT SYSTEM	$ 1,500,000	$ 6,000,000
WORKFORCE TRAINING	$ 500,000	$ 500,000
CUSTOMER ENGAGEMENT PLATFORMS	$ 500,000	$ 500,000
TOTAL CAPEX		$ 58,000,000
ANNUAL O&M (1% CAPEX)	$ 580,000	$ 580,000
TOTAL ESTIMATED		$ 58,580,000

Assumptions for BESS budget calculation:

1. Currently connected households 500,000
2. Each household consumes 150kWh/month of electricity
3. BESS systems provide an average 2hrs of backup in case of outage.

Costs projections based on the report “WILLINGNESS TO PAY FOR IMPROVED ELECTRICITY SERVICES IN SENEGAL”

ELECTRICITY BUDGET

ENERGYNEXUS

SOLAR HOME SYSTEMS — $ 21,100,000

COMPONENT	COST /UNIT ($)	ESTIMATED COSTS
FEASIBILITY STUDY / AWARENESS PROGRAMS	$ 2,000,000	$ 2,000,000
TENDERS AND TAX BENEFITS TO INVESTORS	$ 39	$ 9,750,000
GRANTS FOR BUYERS AMOUNTING TO 50% OF UPFRONT COST	$ 8	$ 1,600,000
TRAINING OF SOLAR AMBASSADOR	$ 250	$ 1,250,000
ACCOUNTABILITY CENTERS & SUBSIDIZED MENTAINANCE	$ 130	$ 6,500,000
TOTAL ESTIMATED COSTS		$ 21,100,000

MINI GRID SYSTEMS — $ 57,310,000

COMPONENT	COST /UNIT ($)	ESTIMATED COSTS
APPEALING TENDERING SYSTEMS	$ 500,000	$ 500,000
LOCAL TRAINING AND AWARENESS	$1,500,000	$1,500,000
METERING COSTS	$250	$ 1,000,000
GRID COSTS	$ 125,000	$ 50,000,000
ANNUAL O&M COSTS (1% CAPEX)	$ 521,000	$ 5,210,000
TOTAL ESTIMATED COSTS		$ 57,310,000

COMPONENT	OUR FUNDING	ACTUAL COSTS
NATURAL GAS POWER PLANT	$ 300,000,000	$ 300,000,000
SOLAR PLANT	$80,000,000	$210,000,000
WIND FARM	$90,000,000	$238,607,594
	$470,000,000	$ 748,607,594

Costs projections based on the report "Scoping study Renewable Energy Senegal"

COOKING FUEL BUDGET

ENERGYNEXUS

COOKING COSTS (RURAL ICS COSTS)

$ 16,351,648

COMPONENT	COST /UNIT ($)	ESTIMATED COSTS
SURVEY AND AWARENESS	$ 3,000,000	$3,000,000
FABRICATION PLANT COSTS	$1,000,000	$ 7,000,000
PROFESSIONALISATION KITS(80%) TYPE-ARTISANA[114]	$15,260	$ 1,391,712
PROFESSIONALISATION KITS(80%) TYPE-PROFESSIONAL[44]	$ 22,490	$791,648
LME SUPPLIMENTARY KITS	$ 3200	$ 2,560,000
WORKFORCE TRAINING(WORKERS AND DISTRIBUTORS)	$ 1,500,000	$ 1,500,000
MARKET MONITORING AND IMPACT VALUATION (10Y)	$ 1,500,000	$ 1,500,000
TOTAL ESTIMATED COSTS		$ 16,351,648

LPG PROGRAM

$ 69,584,400

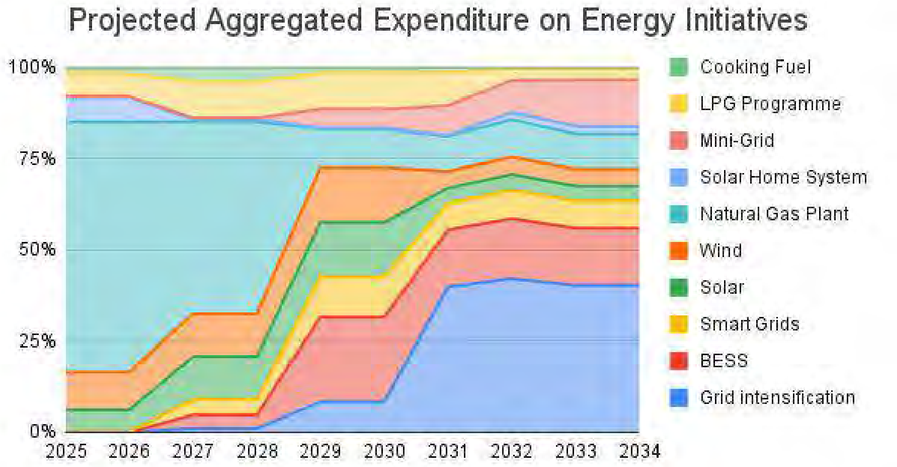
COMPONENT	COST /UNIT ($)	ESTIMATED COSTS
MARKET STUDY / POLICY MAKING	$ 1,000,000	$1,000,000
FILLING PLANTS	$210,000	$1,680,000
LPG IMPORT TERMINAL STUDIES AND RENOVATION (DAKAR & SENDOU-BARGNY)	$10,000,000	$ 20,000,000
DISTRIBUTION INFRASTRUCTURE	$ 4,000,000	$4,000,000
LPG CYLINDER WITH PAYG METERS	$ 50	$ 7,000,000
FREE LPG STOVE DISTRIBUTION (INSTALLMENT PLAN SETUP)	$ 20,000,000	$ 20,000,000
1ST HEAVY SUBSIDIZED (70%) CYLINDER TO CREATE OUTREACH	$8	$ 5,040,000
COMMUNITY CAMPAIGNS AND LOYALTY PROGRAMS	$2,000,000	$ 2,000,000
EXPANSION TO PERI-URBAN AREAS	$6,000,000	$ 6,000,000
MARKET MONITORING & ASSESSMENT	$1,500,000	$ 1,500,000
ANNUAL O&M COSTS (1% CAPEX)		$ 1,364,400
TOTAL ESTIMATED COSTS		$ 69,584,400

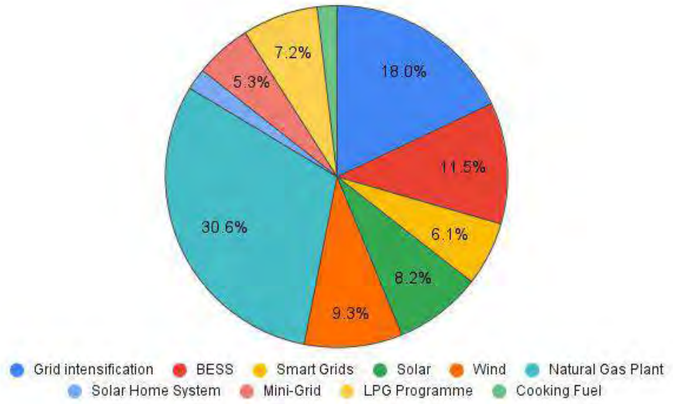
Costs projections based on the report “Promotion Climate Friendly Cooking Kenya and Senegal”

YEAR BY YEAR ANALYSIS OF COST

ENERGYNEXUS

YEAR	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Grid Intensification	0	0	$1,250,000.00	$1,250,000.00	$7,500,000.00	$7,500,000.00	$39,375,000.00	$39,375,000.00	$39,375,000.00	$39,375,000.00
BESS	0	0	$4,178,501.25	$4,178,501.25	$20,892,506.25	$20,892,506.25	$15,321,171.25	$15,321,171.25	$15,321,171.25	$15,321,171.25
Smart Grids	0	0	$4,862,140.00	$4,862,140.00	$9,958,600.00	$9,958,600.00	$7,322,500.00	$7,322,500.00	$7,322,500.00	$7,322,500.00
Solar Farm	$5,333,333.00	$5,333,333.00	$13,333,333.00	$13,333,333.00	$13,333,333.00	$13,333,333.00	$3,999,999.00	$3,999,999.00	$3,999,999.00	$3,999,999.00
Wind Farm	$9,000,000.00	$9,000,000.00	$13,500,000.00	$13,500,000.00	$13,500,000.00	$13,500,000.00	$4,500,000.00	$4,500,000.00	$4,500,000.00	$4,500,000.00
Natural Gas Plant	$60,000,000.00	$60,000,000.00	$60,000,000.00	$60,000,000.00	$9,500,000.00	$9,500,000.00	$9,500,000.00	$9,500,000.00	$9,500,000.00	$9,500,000.00
Solar Home System	$5,875,000.00	$5,875,000.00	$785,000.00	$785,000.00	$240,000.00	$240,000.00	$240,000.00	$1,945,000.00	$1,945,000.00	$1,945,000.00
Mini-Grid	$250,000.00	$250,000.00	$425,000.00	$425,000.00	$4,675,000.00	$4,675,000.00	$8,125,000.00	$8,125,000.00	$12,500,000.00	$12,500,000.00
LPG Programme	$5,500,000.00	$5,500,000.00	$11,340,000.00	$11,340,000.00	$9,010,000.00	$9,010,000.00	$9,010,000.00	$2,940,000.00	$2,940,000.00	$2,940,000.00
Cooking Fuel	$1,500,000.00	$1,500,000.00	$4,591,680.00	$4,591,680.00	$1,353,333.00	$1,353,333.00	$1,353,333.00	$500,000.00	$500,000.00	$500,000.00
Total	$87,458,333.00	$87,458,333.00	$114,265,654.25	$114,265,654.25	$89,962,772.25	$89,962,772.25	$98,747,003.25	$93,528,670.25	$97,903,670.25	$97,903,670.25





Overall Cost Distribution

FINANCIAL PROGRAM AND PLAN

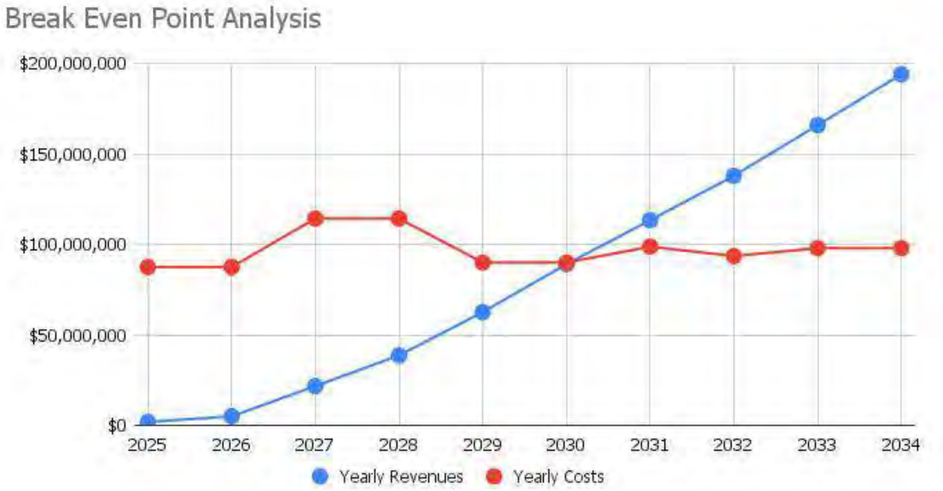
Year	2025	2026	2027	2028	2029	Break even point 2030	2031	2032	2033	2034
Revenue	$1,871,309.30	$4,988,341.15	$21,720,003.12	$38,641,334.04	$62,575,200.00	$89,040,908.88	$113,320,789.99	$137,882,704.68	$165,816,187.99	$193,892,400.00
Cost	$87,458,333.00	$87,458,333.00	$114,265,654.25	$114,265,654.25	$89,962,772.25	$89,962,772.25	$98,747,003.25	$93,528,670.25	$97,903,670.25	$97,903,670.25

Assumptions for revenue model :[Electricity]

1. Average electricity cost per household is $0.18 per kWh at family size of 9 persons
2. Average household electricity consumption is at 1800 KWh/year
3. Average electricity cost to households connected via minigrids is $ 0.15 per kWh
4. No of households served through each mini-grid ~200.
5. 10% implementation margin of error.

Assumptions for revenue model :[LPG]

1. PayG LPG cylinders are of 6KG capacity
2. Each complete refill of LPG costs ~$1.7 /Kg
3. Generaly the cylinder is refilled ~11 throughout the year



FINANCIAL PROGRAM

The Just Energy Transition Partnership (JETP)	$320,000,000 (solar and wind grant)+ $100,000,000 (as loan)
U.S. Agency for International Development	$280,000,00
Government Contribution	$203,783,519
Initial Loan	$583,783,519
Total Revenue Generated(2025 to 2030)	$218,837,096

FINANCIAL PLAN

Pre-break-even (2025-2030): Costs will focus on debt repayment.
Post-break-even (2031-2034): Revenue will cover remaining project costs, with any surplus directed toward further debt repayment.
Overall Funding: The entire project is funded with $203,783,519, or 21% of the total provided funds.

IMPACT ANALYSIS

IMPACT ANALYSIS

SDG DASHBOARDS AND TRENDS POST-IMPLEMENTAITON

ENERGYNEXUS

Our **10-year plan** will elevate **rural energy access** in Senegal, reduce poverty, improve health and education, empower women, protect ecosystems, and strengthen infrastructure—driving sustainable growth across **15 SDGs**.

THE GLOBAL GOALS

1 NO POVERTY — Affordable energy lifts families from poverty through SHS and minigrids.

2 ZERO HUNGER — Clean cooking fuels improve food quality.

3 GOOD HEALTH AND WELL-BEING — Lower indoor pollution reduces respiratory diseases.

4 QUALITY EDUCATION — Less fuel collection time means more education, especially for girls.

5 GENDER EQUALITY — Energy access empowers women, creating economic opportunities.

7 AFFORDABLE AND CLEAN ENERGY — Renewables expand rural access.

8 DECENT WORK AND ECONOMIC GROWTH — Job growth in renewable sectors boosts local economies.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE — Stronger grid, LPG access, and local innovation.

10 REDUCED INEQUALITIES — Energy access narrows urban-rural gaps.

11 SUSTAINABLE CITIES AND COMMUNITIES — Clean energy fosters growth and cuts pollution.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION — Shift to renewables aids sustainability.

13 CLIMATE ACTION — Renewables reduce CO_2 emissions.

15 LIFE ON LAND — Reduced deforestation protects biodiversity.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS — Better energy governance boosts resilience.

17 PARTNERSHIPS FOR THE GOALS — Collaboration drives clean energy progress.

IMPACT ANALYSIS

VARIOUS IMPACTS

ENERGYNEXUS

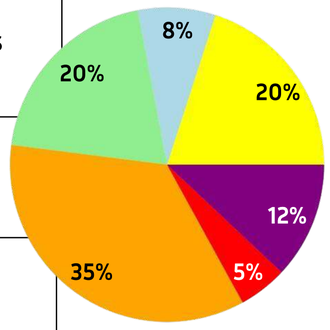
Environmental Impact

1. **Reduced Deforestation:** Better cooking fuels decrease biomass reliance, preserving forests.
2. **Improved Air Quality:** Enhanced fuel usage reduces air pollution.
3. **Better Waste Management:** Improved LPG infrastructure benefits local water sources.
4. **Lower CO2 Emissions:** More renewable electricity reduces CO2 emissions.
5. **Decreased Greenhouse Gases:** Transitioning to clean energy lowers overall greenhouse gas emissions.

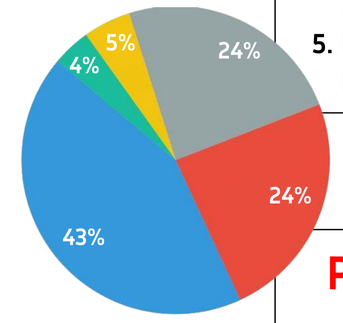
Social Impact

1. **Improved Public Health:** Reduced indoor air pollution enhances health.
2. **Better Education for Children:** More electricity access improves study opportunities.
3. **Time Savings for Girls:** Less biomass collection allows girls to focus on education.
4. **Empowerment of Women:** Efficient cooking frees up women's time for other pursuits.
5. **Sanitation Benefits:** Clean cooking fuels improve food and water sanitation.

2034 ELECTRICITY MIX



2034 ENERGY MIX



Financial Impact

1. **Minimal Fund Dependency:** Limited resources allow funds for other sectors.
2. **GDP Growth:** Boosts GDP through job creation and entrepreneurship in LPG and electricity.
3. **Infrastructure Development:** Investments in LPG terminals, grid technologies, and mini-grids.
4. **Enhanced Trade:** Decreases import reliance and promotes natural gas exports.
5. **Reduced Disparity:** More electricity access boosts productivity for the poor.

Political Impact

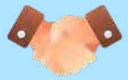
1. **Energy Reforms:** President Bassirou Diomaye Faye is boosting state revenue from natural gas.
2. **Contract Renegotiation:** Plans to renegotiate contracts with companies like BP for economic benefits.
3. **Electricity Access:** Aims for full electricity access through public-private partnerships.
4. **Promotion of LPG:** Advocates for liquefied petroleum gas (LPG) as a cleaner cooking fuel via partnerships and subsidies for improved public health and sustainability.

VISION 2050

PAVING THE PATH TO A GREENER TOMORROW

Targets enlisted in VISION SENEGAL 2050

1. Increase electricity production from 1,740 MW to 12,000 MW by 2050, with tariff reductions and subsidy easing by 2029.
2. Focus on agriculture for self-sufficiency and product processing, and reindustrialize the manufacturing sector.
3. Develop eight regional hubs to distribute resources and infrastructure more evenly.
4. Triple income per capita and achieve annual growth above 6% by fostering competitive sectors and a strong private sector.



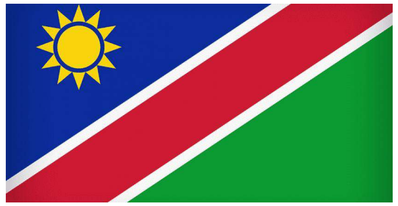
"Collaborative Clean Energy Initiatives: Namibia & Senegal"

1. **Renewable Energy Projects**: Joint solar and wind farm investments leveraging Namibia's wind-rich coast and high solar potential in both countries.
2. **Tailored Renewable Tech**: Joint R&D for desert and coastal conditions, developing durable, high-efficiency solar panels and corrosion-resistant wind turbines.
3. **Green Hydrogen Collaboration**: Co-develop infrastructure, share R&D, and establish trade agreements to build a competitive African green hydrogen market, attracting investment and meeting regional clean energy goals.

Recommended Policies

1. **Carbon Tax**:A phased carbon tax on high-emission industries to drive cleaner energy use, support renewable investment, and fund sustainability programs.
2. **Eco-Labeling Standards**: Introduce eco-labels to promote sustainable practices in agriculture, fishing, and mining.
3. **Circular Economy Framework**: Encourage recycling, waste reduction, and digital tracking for efficient waste management and resource recovery.

SOLUTION TRANSFER PLAN



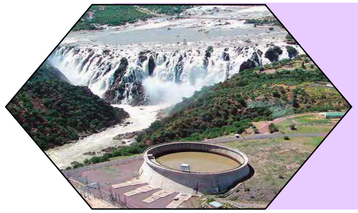
SOLUTION TRANSFER PLAN

CAN SENEGAL'S PLAN BE FRUITFUL IN NAMIBIA

ENERGYNEXUS

" Namibia is at a critical point in its energy transition, where choices about new energy supply today could determine future energy security and prosperity"

Namibia generates less than half the electricity it consumes, with domestic supply struggling to meet rising demand.



Namibia's power comes from five main plants—Ruacana Hydro (330 MW), Van Eck Coal (120 MW), Paratus Diesel (24 MW), ANIXAS Diesel (22.5 MW), and Ombuvu Solar (20 MW)—yet peak demand over 600 MW often leaves the nation short.

Namibia depends on costly power imports, making up 50-70% of annual consumption, mainly from South Africa. However, regional constraints threaten this arrangement.

Namibia relies on the 347 MW Ruacana hydropower plant for over half of its electricity, but it becomes unreliable during droughts.

Namibia is investing in green hydrogen to transition from fossil fuels and position itself as an energy exporter.

Over 55% of the population lacks access to clean cooking fuels, relying heavily on firewood.

ENERGY CRISIS IS DUE TO

- ***Recurrent droughts affecting hydroelectricity***
- ***Insufficient capacity to meet increasing demand***
- ***Heavy reliance on fuel imports for non-renewable energy***
- ***Concentrated Energy mix***

SOLUTION TRANSFER PLAN
ELECTRICITY SCENARIO

TRANSMISSION AND GENERATION STATIONS AND LINES MAP adapted from NAMPOWER

FEASIBILITY OF ON-GRID SOLUTIONS

Grid Intensification (SWER) + Gas Plants with Solar & Wind

Over half of rural Namibians lack electricity; many areas are too remote for feasible grid connection.

Namibia's extensive solar/wind potential remains untapped, with over 300 sunny days per year.

Untapped encroacher bush can fuel the planned 40 MW Otjikoto Biomass Power Station.

Baynes Hydroelectric (600 MW) is planned, but gas from the Orange Basin will take years to impact energy needs.

Market Liberalization could add 300 MW Solar PV and 200 MW wind.

Hybrid renewable grids with LV lines can bridge power shortages and connect rural areas.

FEASIBILITY OF ON-GRID SOLUTIONS

BESS + Smart Grids

Heavy reliance on imports and variable renewable energy sources challenge grid stability

BESS can store excess renewable energy or cheaper imports for peak use, supporting supply security

Enables balanced trade within the SAPP and boosts energy resilience.

FEASIBILITY OF OFF-GRID SOLUTIONS

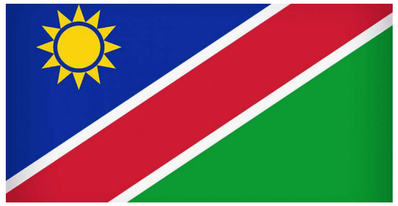
Mini-Grids & Solar Home Systems (SHS)

Only 33% of rural areas have electricity, with high mini-grid costs lacking subsidies.

300,000+ households remain off-grid; mini-grids are key for expanding access.

Project PROCEED promotes sustainable off-grid systems.

Subsidies (similar to Senegal's model) and better SHS after-sales services can drive rural adoption.



SOLUTION TRANSFER PLAN
COOKING FUELS SCENARIO

ENERGYNEXUS

Background:

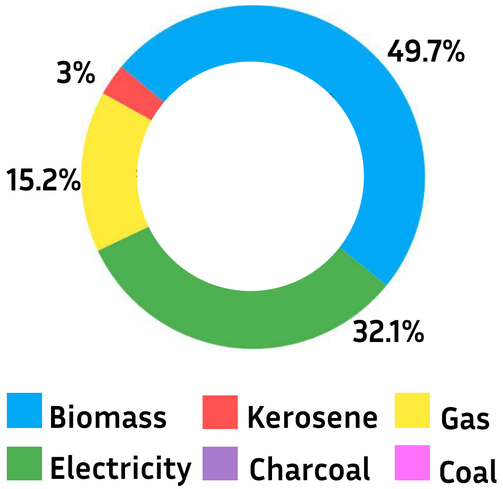
1. Over 53% of population lacks clean cooking fuels.
2. 85% of rural households rely on biomass.
3. This reliance causes deforestation and health issues.
4. Namibia imports all its LPG.

Improved Cookstoves (ICS) could reduce firewood reliance in rural Namibia by following Senegal's approach. For effectiveness, Namibia should emphasize affordability and cultural engagement, as demonstrated by programs like NaDEET to address local economic and cultural factors

CHALLENGES IN NAMIBIA

- Infrastructure Gaps: Limited LPG distribution networks, unlike Senegal.
- High LPG Costs: Fully imported LPG is costly, impacting affordability for lower-income households.
- Urban Cooking Trends: Nearly 46% of urban Namibians rely on electric stoves for cooking, attributed to high literacy rates

NAMIBIA'S COOKING FUEL MIX



SUCCESS POTENTIAL

- Electric Stove Transition: Focusing on electric cooking for urban areas may be more sustainable and cost-effective.
- Economic Factors: Senegal's subsidies and established LPG networks make its approach difficult to replicate in Namibia.
- Cultural Fit: Namibia's urban population may be more open to electric cooking, unlike LPG-focused Senegal.

While Namibia can learn from Senegal's experiences, tailored strategies addressing specific barriers are crucial for success

*Desert Environmental Education Trust

BUILDING RESILIENCE:
PREPARING FOR POTENTIAL SETBACKS IN ENERGY PLANS

Minimal Risk of Complete Failure:
With diverse renewable sources and subdivisions, the likelihood of a total plan failure is low.

Pilot testing risk prone plans:
we have already adapted the iterative approach by pilot testing high investment hig risk plans to avoid faliure of the plan.

Adopt Time-Tested Strategies:
Leverage successful models from similar contexts to lower risk and build on proven approaches The "Pay-As-You-Go" (PAYG) model has seen success in other Sub-Saharan regions, ensuring scalable access to LPG, which can boost adoption and minimize risks.

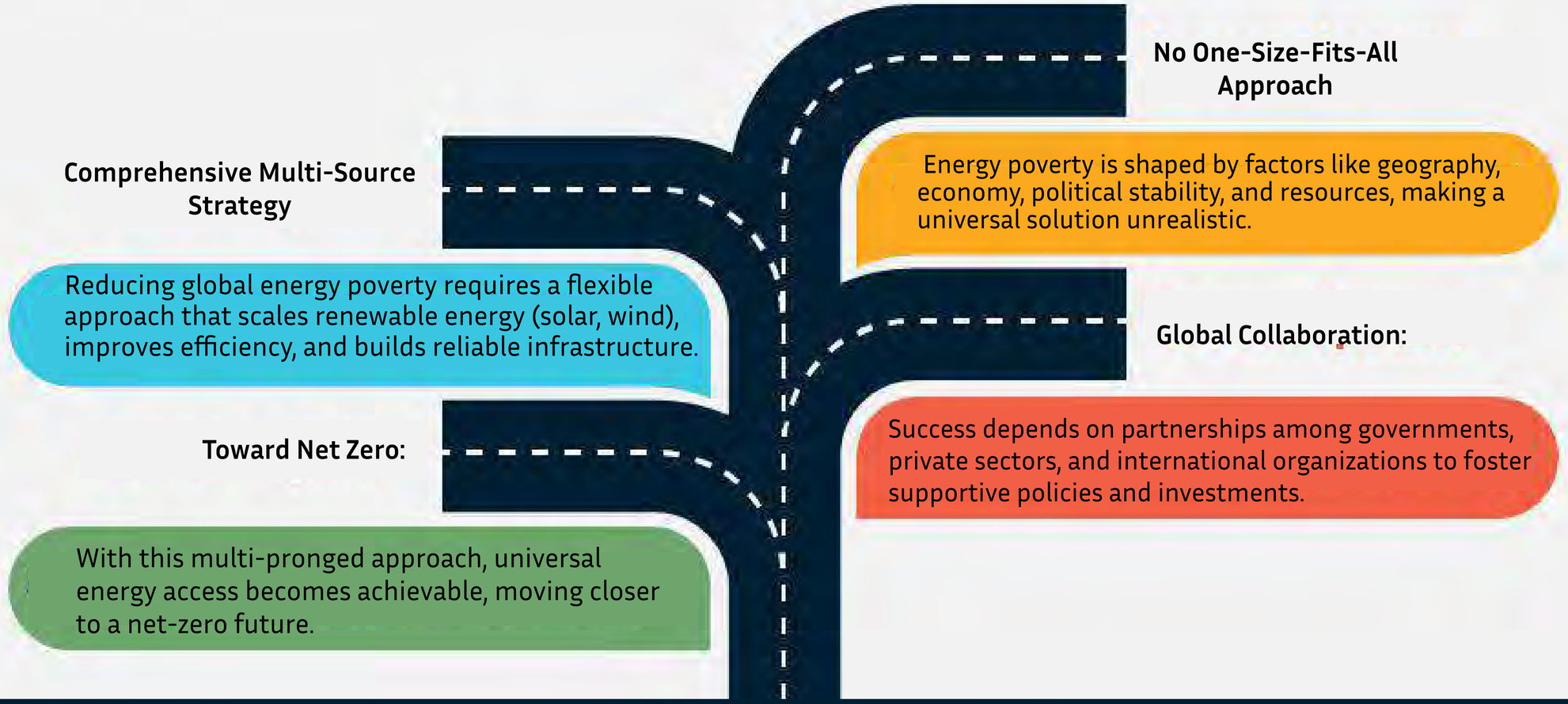
Engage a "Crisis SWAT Team":
Establish a rapid-response team to handle supply chain, technical, or community issues swiftly, ensuring project stability and minimizing risks.

"Survival of the Fittest" Solutions:
Regularly assess and expand only the most effective technologies and strategies based on local performance.

Secure Against External and Stakeholder Risks:
Reduce import reliance and market vulnerability while ensuring strong stakeholder commitment for project resilience.

CAN THERE A SINGLE SOLUTION FOR GLOBAL ENERGY POVERTY?

ENERGYNEXUS



"MULTIPLE PATHS LEAD TO A SUSTAINABLE AND INCLUSIVE ENERGY FUTURE"

REFERENCES 1

1. **Country Economy Website:** https://countryeconomy.com/countries/compare/senegal/namibia
2. **Resources of Timeline of Namibia:** Namibia Electricity Control Board (ECB) Reports
   NamPower Annual Reports
   - Southern African Power Pool (SAPP) Reports
   - Ministry of Mines and Energy (MME) Publications
   - Kudu Gas Project Feasibility Reports
   - National Planning Commission, Namibia
   - Updated Renewable Energy Policy (2018)
   - National Energy Policy Document
3. **Resources of Timeline of Senegal:**
   - Senegalese Ministry of Energy Reports
   - SENELEC Annual Reports
   - World Bank Reports
   - Oil and Gas Exploration Reports
   - Renewable Energy Law Document
   - Scaling Solar Program Reports
   - Government Economic Reforms Document
   - Gas Master Plan Documents
4. **Resources of Poverty Factors:**
   - **IRENA Analysis of Nambia:**https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Africa/Namibia_Africa_RE_SP.pdf
   - **World Bank:** https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=SN
   - **IEA Analysis of Senegal:** https://www.iea.org/news/strong-energy-foundations-support-senegal-s-ambitious-plans-to-ramp-up-sustainable-economic-growth
   - **WILLINGNESS TO PAY FOR IMPROVED ELECTRICITY SERVICES IN SENEGAL:Almanzar* and John Ulimwengu****:https://assets.mcc.gov/content/uploads/paper-willingness-to-pay-for-improved-electricity-services-in-senegal.pdf
   - **Global Economy : Namibia:**https://www.theglobaleconomy.com/Namibia/electricity_imports/
   - **Global Petrol Prices Senegal:** https://www.globalpetrolprices.com/Senegal/electricity_prices/
   - **Global Petrol Prices Nambia :**https://www.globalpetrolprices.com/Namibia/electricity_prices/

REFERENCES 2

5. **TRACKING SDG 7:** https://trackingsdg7.esmap.org/country/senegal
6. **openinframap:** https://openinframap.org/stats/area/Senegal
7. **IEA Energy Overview Policy 2023: Senegal :** Senegal, https://www.iea.org/reports/senegal-2023
8. **2022-WLPGA statistics**
9. **Senegal's Gas-to-Power Ambitions: Securing Scale and Sustainability PAPA DAOUDA DIENE, THOMAS SCURFIELD, AARON SAYNE AND JESSICA OBEID JUNE 2024:** *https://resourcegovernance.org/sites/default/files/2024-07/Senegal-Gas-to-Power-Ambitions_Securing-Scale-Sustainability.pdf
10. **POWER GENERATION AND TRANSMISSION MASTER PLAN FOR SENEGAL**
11. greenminigrid.afdb.org (a pdf on the electrification of Senegal)
12. **Senegal Rural Electrification Program Behavioral Diagnostics from worldbank.org**
13. **For Mini-Grid:**
    - Senegal-Rural-Electrification-Program-Behavioral-Diagnostics-Note PDF (documents1.worldbank.org)
    - PAOP-Senegal-MarketAssessment-Final_508 PDF (www.usaid.gov)
    - https://energycapitalpower.com/senegal-clean-energy-scaling-solar-program/
    - https://www.scalingsolar.org/active-engagements/senegal/
    - https://www.sciencedirect.com/science/article/pii/S1364032123002071
14. **Solution for cooking fuel scenario in Rural:**
    - Promotion Climate Friendly Cooking Kenya and Senegal: https://www.giz.de/en/worldwide/123269.html
15. **Financial Plan:**
    - Costs projections based on the report "WILLINGNESS TO PAY FOR IMPROVED ELECTRICITY SERVICES IN SENEGAL": https://assets.mcc.gov/content/uploads/paper-willingness-to-pay-for-improved-electricity-services-in-senegal.pdf
    - Costs projections based on the report "Scoping study Renewable Energy Senegal": https://www.rvo.nl/sites/default/files/2022/02/Scoping-study-Renewable-Energy-Senegal.pdf

REFERENCES 3

16. **Solution Transfer Plan:**
    - ITA: https://www.trade.gov/
    - Least-cost energy investment study for Namibia: https://www.internationalrivers.org/wp-content/uploads/sites/86/2023/07/TMP-report-Namibia-2023.pdf
    - Desert Environmental Education Trust: https://nadeet.org/namib-desert-environmental-education-trust-nadeet
17. **Miscellaneous:**
    - https://assets.mcc.gov/content/uploads/paper-willingness-to-pay-for-improved-electricity-services-in-senegal.pdf
    - https://www.pnnl.gov/sites/default/files/media/file/Final%20-%20ESGC%20Cost%20Performance%20Report%2012-11-2020.pdf
    - https://www.greenclimate.fund/document/promotion-climate-friendly-cooking-kenya-and-senegal
    - https://www.sciencedirect.com/science/article/pii/S0306261921002762?ref=pdf_download&fr=RR-2&rr=8d931eb9be30415e20
18. **TRANSMISSION AND GENERATION STATIONS AND LINES MAP:**https://www.kas.de/documents/279052/279101/Smart+Grids+and+their+Potentials+in+Namibia%27s+Electricity+Sector.pdf/beaffb58-5180-0dbe-6a43-ff2bf9f6918b?version=1.1&t=1626250360269#:~:text=Smartening%2Dup%20Namibia's%20electricity%20grid,NamPower's%20management%20and%20control%20system
19. **Based on SENEGAL Long-Term Vision 2050 Pathways Platform – Annual Meeting Series:** chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://2050pathways.org/wp-content/uploads/2023/07/Senegal_Country-experiences-with-the-development-of-a-long-term-vision_Senegal.pdf

APPENDIX

RANKING FOR COMPARATIVE ANALYSIS OF SENEGAL AND NAMIBIA

ENERGYNEXUS

Accessibility
1: Very limited access to electricity and clean cooking fuels; mostly unavailable or unreliable.
2: Restricted access; a significant portion of the population lacks basic energy services.
3: Moderate access; available to most urban areas with limited rural availability.
4: High access; energy services widely available in both urban and rural areas.

Environmental Impact
1: High environmental impact; heavy reliance on fossil fuels with significant CO_2 emissions.
2: Moderate impact; some renewable integration, but fossil fuels still play a dominant role.
3: Low impact; considerable use of renewables and low emissions.
4: Minimal impact; primarily renewable energy with very low emissions.

Quality of Energy Services
1: Very poor quality; high transmission and distribution losses, poor efficiency, frequent voltage issues.
2: Low quality; moderate losses and efficiency, voltage issues present in some areas.
3: Good quality; minimal losses, reliable energy services with occasional disruptions.
4: Excellent quality; high efficiency, very low losses, stable and consistent voltage.

Reliability
1: Very unreliable; frequent outages and interruptions.
2: Somewhat unreliable; occasional power cuts and reliability issues.
3: Fairly reliable; few outages and interruptions.
4: Highly reliable; very rare outages, consistent power supply.

Affordability
1: Very high costs, inaccessible for lower-income households.
2: Moderately high costs, significant burden on household income.
3: Affordable for most households, manageable impact on income.
4: Very affordable; minimal impact on household expenses.

Safety
1: High health risks; widespread indoor pollution and unsafe cooking practices.
2: Moderate health risks; pollution and unsafe energy practices are present but less severe.
3: Low health risks; minimal pollution, mostly safe energy practices.
4: Very safe; clean energy sources with negligible health risks

Security
1: Very insecure; heavy reliance on energy imports, vulnerable to external disruptions.
2: Somewhat insecure; moderate reliance on imports, exposed to risks.
3: Fairly secure; low reliance on imports, some internal energy resources.
4: Highly secure; self-sufficient with minimal import reliance.

Potential for Roadblocks
1: Significant obstacles; economic, political, or social issues severely hinder progress.
2: Some roadblocks; moderate economic or political challenges.
3: Few roadblocks; minimal interference from economic or political issues.
4: Very few to no roadblocks; strong support and minimal barriers

Political Redirection
1: Weak political support; limited or no efforts toward sustainable and inclusive energy policies.
2: Moderate political support; some efforts toward reforms, but progress is limited.
3: Good political support; reforms are in place, and there's steady progress.
4: Strong political support; active government commitment to sustainable and equitable energy policies.

SWITCH ENERGY CASE COMPETITION 2024

TEAM ENERGY NEXUS

Bhumi Periwal

Sanika Kole

Md Merajuddin Ahmed

Kunal Prasad