ENERGY
CATALYST

Country Guide: Namibia

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The Republic of Namibia is a large arid country on the southwestern coast of Africa, bordered by Botswana to the east, South Africa to the south, and Angola and Zimbabwe to the north. With a population of just over 2.45 million and a land area of 825,615 km, Namibia is the fifth least-densely populated country in the world. Namibia has four broad climate zones: in the northeast, a subtropical area known as the Caprivi Strip; the Central Highlands (home of Windhoek, the capital), characterised by a temperate, continental climate; the Kalahari Desert in the east, which is arid but receives more precipitation than the Namib region; and the Namib Desert, extending across the

Figure 1: Map of Namibia. Source: d-maps

Western coastline, which is harsh and almost rainless.

Government

Namibia achieved independence from South Africa in 1990 and has since been led by the governing party, the South West Africa People's Organisation (SWAPO), through a constitutional, multiparty democratic system. SWAPO was most recently re-elected in the 2019 general election, winning 56.25%[1]of the votes; this is down dramatically from the 80% of votes they received in the 2014 election.

Namibia has considerable mineral wealth, which is the main reason for the apartheid South African government maintaining control of Namibia throughout its struggle for independence from 1966 to 1990.

Today, Namibia is still closely aligned to South Africa, its processes and institutions. Its currency, the Namibian Dollar (NAD), is still pegged to the South African Rand, and the Reserve Bank (the Bank of Namibia) largely aligns itself with the stance of the South African Reserve Bank (SARB).

Table 1. Namibia at a glance

Capital	**Windhoek**
Total Area	**825,615 Km2**
Population	**2.82 million (2023)**
Official languages	**English**
Rural population	**46% (2022)**
GDP	**USD $12.61Billion (2022)**
GDP per capita	**USD $4,911.3 (2022)**
Currency	**Namibian Dollar (NAD)**
Exchange rate (as of 05/07/2023)	**1 GBP= 20.90 NAD**
Access to electricity	**55.2% (2021) World Bank**
Urban electricity access	**74.7% (2021)**
Rural electricity access	**33.2% (2021)**

Namibia is a member of the African Union, the United Nations, the Commonwealth of Nations, and the Southern African Development Community (SADC).

Economy

Namibia is an upper-middle income country. Its economy ran into trouble in the second half of the last decade: after growing by 4.3% in 2015, it stagnated in 2016, then dipped by 1.0% in 2017, before plummeting into recession with an 8.1% drop in 2020. However, Namibia posted a growth rate of 4.6% in 2022, as shown in Figure 1 below. This rebound is attributed to positive performances in primary and secondary industries, buoyed largely by investments in the mining sector and expansive government fiscal policies. The primary and tertiary sectors are the largest contributors to Namibia's GDP, at 55.5% and 20.8% respectively, as of 2022. The primary sector is dominated by mining activities: the major minerals mined in Namibia are diamonds, copper, gold, and uranium. Other industries include manufacturing, construction, fishing, agriculture and forestry. The secondary sector includes retail and

[1] For more information on the outcome of Namibia's 2019 presidential elections, see Table 3 of the report by the Institute for Public Policy and Research (IPPR).

wholesale, hotels, restaurant and allied services, education, health etc. The tertiary sector is more diverse and is underpinned by a strong, well-developed financial sector that is liquid and well-capitalised. The tertiary sector contributed 55.5% of the GDP of Namibia, followed by the primary sector at 20.8%, the secondary sector at 15.8%.

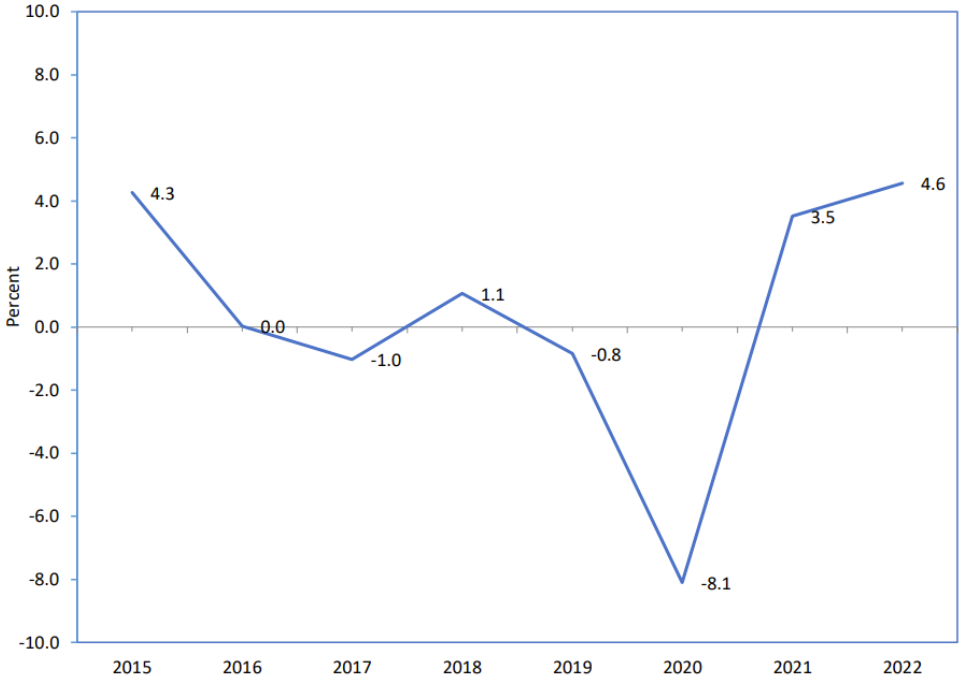

Figure 1. GDP growth rates as a percentage, 2015-2022. Source: Namibia Statistics Agency 2022.

According to the Vision 2030 document, Namibia seeks to become a prosperous, peaceful, stable and industrialised nation by 2030. This economic blueprint contains multiple development strategies and integrated implementation approaches. The Vision 2030 targets for Namibia are:

- Reduce unemployment from 35% to 5%
- Reduce inequality through a reduction in the Gini-coefficient from 0.7 to 0.3
- Achieve high-income status according to per capita income
- Increase the contribution from manufacturing and the services sector to 80% of GDP

The 5th National Development Plan (NDP 5) was part of a series of six NDPs providing guidelines for the implementation of Vision 2030 and was in force between 2018-22. Under the plan, the envisaged outcome was to build local power installed capacity to 755MW[2] and increase electrification rate to 50% by end of 2022 to support households and industrial needs. These aspirations were partly met, as the electrification rate reached 55.23% by end of 2021 according to World Bank data. The generation capacity however, in 2023, is 640MW and yet to reach the 2022 target of 755MW. The challenges to realizing the plans include: the vastness of the country; low densities of demand owing to sparse nature of population distribution; and long distances between major load centres requiring high capital

[2] Namibia's 5th National Development Plan, see page 34 on energy.

investment for power evacuation from generation sites, transmission, and distribution. In its efforts to implement Vision 2030, the long-term aspirations of the NDP5 with respect to energy included:

- Expanding bulk transmission and distribution infrastructure for increased power generation to 755MW by increasing public spending and investment in power generation.
- Harness indigenous resources for generating energy by incentivising ongoing research in technology development and human resources skilling in the power generation sector.
- Promotion of independent Power Producers (IPPs) for targeting mining, water pumping, construction and urban development sectors. They would generate power from indigenous resources like biomass, wind and solar.
- Transforming the power market structure by deliberately introducing competition in order to discourage monopolies and subsequently reduce the cost of power.

In June 2023, the National Planning Commission (NPC) launched the review and formulation process of the 6th and final National Development Plan (2023-2030). This development plan was launched under the theme: "intensify economic recovery, inclusiveness and resilience to ensure quality and sustainable development for all Namibians". The review and formulation of the new development plan coincides with implementation of the Harambee Prosperity Plan II (2021-2025), which focuses at implementing policy programmes that enhance service delivery, economic recovery, and creation of opportunities. The five pillars under the Harambee Prosperity Plan (HPP)[3] include: effective governance, economic advancement, social progression, infrastructure development and improving international relations and cooperation. Under the pillar of infrastructure development, energy supply security is given significant prominence.

According to World Bank data, the unemployment rate was at 20.8% as of 2022. In the now discontinued annual World Bank survey on 'Doing Business', a comparison of business regulation in 190 economies, Namibia scored higher than the sub-Saharan African average. In the last edition, Namibia was ranked 104 out of 190, with a score of 61.4 out of 100 for the ease of starting a business. Figure 2 provides the ranking and scores of Namibia compared to other economies for various 'Doing

Figure 2. World Bank doing business 2020 global rankings and scores for various 'Doing Business' topics in Namibia. Source: World Bank Group, 2020.

[3] For more about Harambee prosperity Plan II, visit https://www.npc.gov.na/dg-remarks-ndp6-hpp2/

Business' metrics, showing areas where Namibia is performing well and those that need to be improved. Contracting, access to credit and electricity are areas where Namibia is competitive; registering property, the time and effort needed to start a business and cross-border trading are areas that need improvement.

The energy sector in Namibia

As of 2020, Namibia had 640MW[4] of installed electricity generation capacity, of which 579.5MW was available. The majority of the total installed capacity comes from the Ruacana hydroelectric powerplant (347MW), van Eck 120MW coal powered station and Anixas 22.5MW powered by heavy fuel oil (HFO). The total installed capacity from IPPs (independent power producers) is 70MW comprising of solar PV at 65MW and wind at 5MW, with an additional 52MW from off-grid sources. According to the Harambee Prosperity Plan II, Namibia plans to add 239 MW by the end of 2025, reaching a total of 879MW. Owing to the current pace of developing new generation capacity, this target is unlikely to be met. However, significant new additional capacity will be met as the country completely recovers from economic shocks of the pandemic and the ensuing recession. 70MW of IPP generated power and an additional 150MW from NamPower generation is planned for before 2025. Most of the IPPs will have been completed by then adding at least 218MW online by 2025.

The peak electricity demand in Namibia was estimated at over 755MW in 2022, meaning that Namibia is an electricity importer, largely from South Africa and to a lesser extent the other Southern Africa Power Pool (SAPP) states. In terms of production and consumption, Namibia produced an estimated 1180GWh of electricity in 2022, 816GWh internally and 364GWh from the Renewable Energy Feed-in Tariff programme (REFIT) and IPPs. South Africa supplied 1253GWh through ESKOM, the Zambia Electricity Supply Corporation Limited (ZESCO) supplied 1018GWh, the Zimbabwe Power Company (ZPC) supplied 390GWh, and an additional 256GWh was purchased from the SAPP expensive short-term energy market. This makes Namibia a net importer of electricity at 71.2%, and is therefore increasingly vulnerable to changes in the Southern Africa region's energy markets, as depicted in Figure 3 below.

[4] *Least-cost energy investment study for Namibia* (TMP Public, 2023).

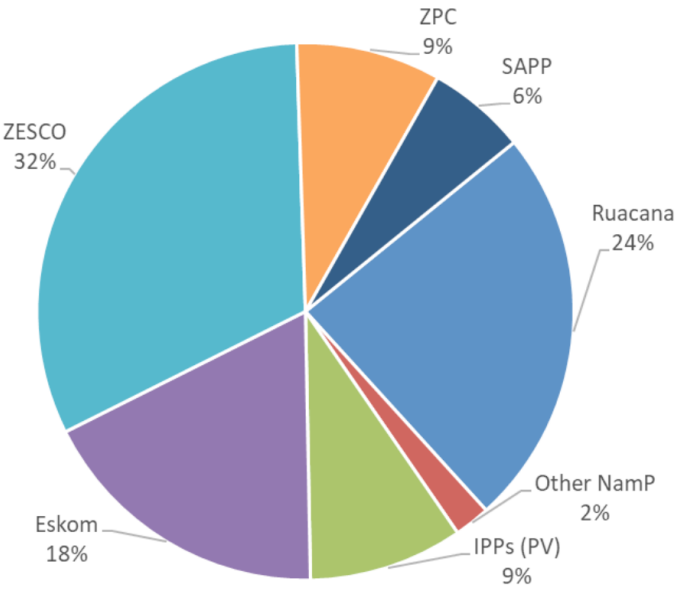

Figure 3. Electricity supply in 2022. Source: NamPower Report.

Looking at the energy sector more broadly, the total primary energy supply (TPES) in Namibia in 2020 was 23.306GWh. 13,751GWh of this TPES came from crude oil, which was imported into the country. In 2018, more than half (57%) of the crude oil was used in the transport sector, and 10% was used in industry. Lastly, bioenergy contribution was estimated at 6,635GWh.

Namibia is well-endowed with energy resources beyond the existing hydropower resources and natural gas (neither of which have been fully exploited). It has the potential to tap into all available renewable energy sources with the exception of geothermal. Geological data suggests that there are considerable oil and gas reserves in the Walvis, Luderitz and Orange River offshore basins. BW Energy (BWE), a Norwegian operator, has reported significant advancements in the development of the Kudu gas offshore project. Additional prospecting on the existing license confirmed the availability of additional gas resources and shallower oil targets, thereby de-risking the project. BWE has since signed an Engagement Protocol with NamPower, covering the project feasibility process, and a term sheet for the Power Purchase Agreement (PPA), including plans for final negotiations. Commercial production of gas is expected to begin by 2026, after the final investment decision is made in 2024. The gas production is projected to peak in 2031, with 83bpd of crude oil and 108Mmcdf of natural gas. The gas will be reticulated through a 170km pipeline to a power station that will be built in Uubvlei, Southern Namibia. This aims to generate 885MW of power through a combined cycle thermal plant, and to increase this to 1050MW later on. Only 400MW will be used locally; the rest will be transported to South Africa and the SAPP, to be used regionally.

Namibia has considerable solar, biomass, hydropower and wind energy resources; while the total installed renewable energy capacity was 489MW in 2023, the total opportunity is many times greater. The solar potential in Namibia, according to its National Integrated Resource Plan's estimations, has "no limit", while the biomass, wind and hydro potential was estimated at 600MW, 300MW and 300MW, respectively.

The Namibian government's energy sector goal, according to its 2022 Integrated Resource Plan, is to increase Namibia's capacity of locally-generated power to 80% by 2028 and achieve a renewable energy

capacity of 70% (796.6MW) as a share of the total installed capacity by 2030, as envisioned in the renewable energy policy. This improvement will enable it to support households and industry needs, reduce reliance on imports by limiting it to at most 20%, and increase the national electricity access rate from 49% in 2018 to 67.5% by 2023. The strategy is to increase power generation to 879MW by the end of 2025, a further 1138MW by 2030 and 1677MW by 2035.

Key to achieving the National Development Plan (NDP) objective for the energy sector is to overcome the present challenges facing the country, which, in relation to the energy industry, include:

- Accessibility and security of developer funding.
- Inability to meet current energy demand, compounded by reliance on hydropower in an increasingly drought-stricken region.
- Maintenance and refurbishment of existing assets to increase availability.
- Attracting and developing key skills in the industry.

Currently, the Namibian electricity sector is undergoing progressive liberalisation, after years of monopoly by the Namibian Power Corporation (NamPower). NamPower is responsible for generation, transmission, distribution, trading and connecting end-users. In efforts to create a cost-reflective market, the government has since opened the sector to private entities to attract investment. The Modified Single Buyer Model (MSBM) replaced the Single Buyer Model, which curtailed the entry of IPPs at the expense of NamPower. In this model, contestable customers would purchase power from IPPs termed as eligible sellers. From 2026, private entities are eligible under the plan to trade electricity, but private connections to households will be handled by regional electricity distributors (RED) and existing municipal utilities. Figure 4 below shows some locations in Namibia where IPP-led projects have been executed and are currently generating electricity.

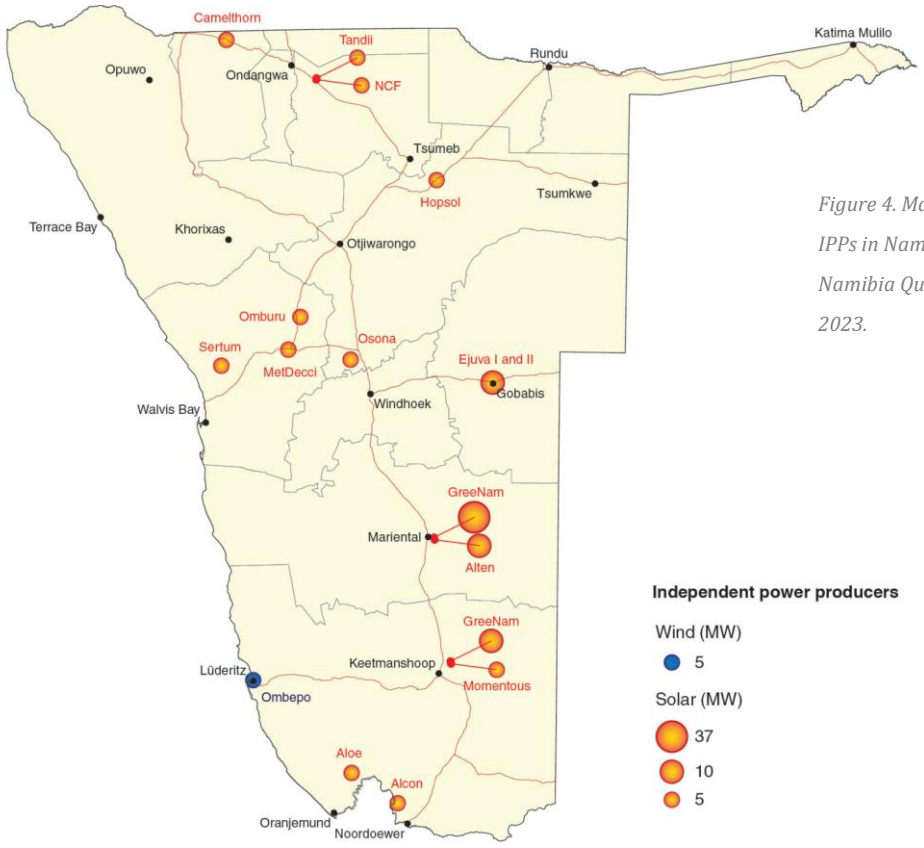

Figure 4. Map showing current locations of IPPs in Namibia as of 2022. Source: Namibia Quarterly Economic Review, 2023.

Three REDs now operate in Namibia from an initial 17. These include the Northern Regional Electricity Distributor (NORED), Erongo Regional Electricity Distributor (ErongoRED) and Central-Northern Regional Electricity Distributor (CENORED). Two more REDs, the Southern Regional Electricity Distributor (SoRED) and Central Regional Electricity Distributor (CRED), have been envisaged but are yet to be set up. NamPower generates power and supplies bulk power to the regional distributers, mines, NamWater, and city and municipal utilities, like the City of Windhoek and other local authorities where REDs do not operate.

The Namibian government intends to expand generation capacity to 1677MW and diversify the generation mix that will be composed of 60% (4947GWh) renewable energy by 2035. There has been interest from private entities, large consumers, at self-generating electricity, owing to higher tariffs, which have more than doubled in a decade from $0.045 per kWh in 2011 to $ 0.095kWh in 2022. In addition, end consumers, pay more on the cost of a unit of power due to marginal increases in pricing for regional electricity distributors and utilities. This means renewable energy plants would be competitively implemented at economies of scale without the need for subsidies. 510MW is planned for connection to the grid by 2030, and 708.5MW by 2035. NamPower is competitively floating tenders and entering PPAs with IPPs for solar and biomass energy generation across Namibia, under the REFIT programme and others out of the scope. Net metering is possible for prosumers generating below 500kW, as no production license is required for this. With the highly spread-out distribution of populations in Namibia, entities that generate off-grid power can explore net metering as a solution for

electrifying areas connected through isolated grids. Net metering is viable for electrifying rural communities not served by the grids, as densification is only feasible in the longer term.

Below is a review of the renewable electricity generation technologies currently employed in Namibia.

Hydropower

The Ruacana Hydroelectric Power Station, Namibia's flagship power station, was commissioned in 1978 with a total project cost of NAD $162 million. It originally consisted of three 80MW turbines, with another 90 MW turbine added in 2012. It was designed as a run-of-river plant on the Kunene River, on Namibia's norther border with Angola.

NamPower, the national electricity utility, is currently upgrading the facility to increase output from the current 332MW to 347MW. Unfortunately, due to the climate and rainfall patterns in the country, the peak power supply is not synchronised with the peak demand period (June through July), as the power plant produces half the amount of power in the winter months as it does from January to May. During the long drought of 2020, only an average 40% generation capacity was attained.

Even though Namibia is an arid country, the theoretical hydropower resource potential is 2,250MW, so additional capacity could still be exploited from the Kunene River. In March 2020, the Namibian and Angolan Governments signed a bilateral agreement for the construction of the cross-border 600MW Baynes Hydroelectric Power Station on the Kunene River, which will cost an estimated USD $1.2bn. The construction began in 2023 and it is scheduled to enter commercial operations in the first quarter of 2029. Upon completion, the plant will see 300MW of electricity directed to each of Angola and Namibia.

An assessment by Riverscope, on least-cost investment pathways for Namibia, discounts the sustainability of developing big hydropower projects. According to their modelling of the future energy scenario until 2040, alongside comparative modelling for development of the proposed Baynes hydropower project, the cost (including social and environmental risks) and benefits associated with developing alternatives like solar and wind is more sustainable when compared with large hydropower projects. The analysis indicates that solar, wind and storage have significant potential for shaping Namibia's energy future in the decade from 2030 onwards by accounting for 70-77%[5] of local installed capacity.

Table 2. Overview of the main stakeholders in the energy sector in Namibia

Institution	Role
Ministry of Mines and Energy (MME)	Policy setting and overall regulation of the Namibian energy sector. Through its energy directorate, the ministry is further responsible for the implementation of Namibia's energy policies and enforces compliance to legal requirements under allied Acts. The directorate also conducts research on innovation and renewable energy, spearheads energy planning and implements the national electrification programme, which includes rural electrification and electricity supply industry restructuring through the formulation of new policies.

[5] *Least-cost energy investment study for Namibia* (TMP Public, 2023).

Table 2. Overview of the main stakeholders in the energy sector in Namibia	
Ministry of Environment and Tourism (MET)	MET sets policies, plans and regulations regarding climate change and environmental protection in Namibia. It also regulates EIA procedures and advances climate change activities in Namibia.
Ministry of Finance (MF)	Provides funding for all government ministries and regulates the national, provincial and municipal financial management according to legislation.
Ministry of Trade and Industry (MTI)	Enhances and attracts foreign direct investments into the energy sector.
National Planning Commission (NPC)	Plans national priorities, promulgating development objectives and strategies, and sets sectoral plans and budget allocations.
Electricity Control Board (ECB)	Established in 2000 to regulate electricity generation, transmission and distribution, which includes setting electricity tariffs and reviewing and issuing licenses for importation, exportation and trade of energy products. It also provides recommendations to the MME regarding energy sector policies.
National Technical Committee on Renewable Energy (NTCRE)	Develops standards and codes of practice for performance, manufacture, installation and maintenance of renewable energy technologies that enter the Namibian market.
NamPower	Owns and operates most electricity generation and all transmission assets in Namibia. An electricity system operator and trader, it balances supply and demand.
Regional Electricity Distributors (REDs)	State-owned entities that control the supply and distribution of electricity in dedicated regions in Namibia. Currently there are three, with two more planned.
Namibia Energy Institute (NEI)	Conducts and disseminates research, as well as capacity building and raising awareness on renewable energy technologies, energy efficiency, oil, natural gas and nuclear energy. Provides technical assistance to the MME for renewable independent power producers.
SADC Centre for Renewable Energy and Energy Efficiency (SACREEE)	SACREEE was established by SADC in 2015 to contribute towards increasing access to modern energy services and improving energy security across the SADC region, through the promotion of market-driven uptake of renewable energy and energy-efficient technologies. SACREEE will play a key role in implementing the Southern African Renewable Energy and Energy Efficiency Strategy and Action Plan, and in harmonising policy approaches, regulation and standards, investment coordination, regional capacity building and knowledge building measures.

Solar energy

Namibia has one of the greatest solar resources in the world. Being a large country with a low population density, land is readily available. In terms of insolation, Figure 5 illustrates the high resource potential in Namibia, which is available for more than 300 days per year and an average of at least 10 hours per day. Averaging between five and six kWh/m^2, the Southern Namib and Kalahari regions receive the most solar radiation. Excluding the land area used for agriculture (47%), conservation (17%) and urban areas (<1%), the theoretical solar potential for Namibia is in excess of 1,445TWh per annum, or nearly 350 times the current electricity demand.

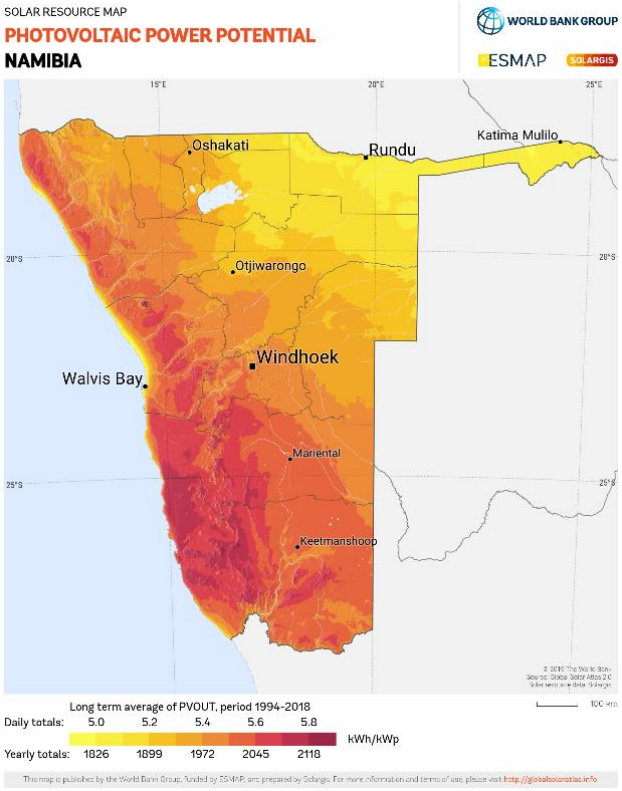

Figure 5. Solar resource Namibia (2019). Source: Global Solar Atlas 2.0, Solar resource data: Solargis.

In 2015, the Electricity Control Board (ECB) established the REFIT programme, which was applicable to solar PV, biomass and wind energy technologies. Under this programme, renewable energy projects between 500kW and 5MW would be procured by the utility, NamPower. The REFIT programme was generally well received and, to date, it has seen 14 projects reach financial close. 11 are connected to the national grid, with a total power capacity of 70 MW. Of these 14 connected IPPs, 13 are solar PV projects with capacities of 5MW, making the REFIT solar PV capacity 65 MW, as of 2022.

Outside the REFIT programme, several solar PV projects have been developed, which include the Omburu Sun Energy project (4.5MW) in the Erongo region and HOPSOL Power Generation (5MW) in Grootfontein, Otjozondjupa which have both been operational since 2016. These projects were the first power purchase agreements that NamPower ever signed with private IPPS.
In 2018, the two 10MW GreenNam Electricity solar PV projects and the 37MW Hardap Solar PV Park were commissioned, supplying an additional 47MW to the NamPower grid (5% of the country's annual electricity demand). These projects are still active and continue to immensely diversify the energy mix of Namibia, by reducing the vulnerability of the power system associated with hydropower stations' reduced capacity during drought.

In the pipeline, the 80MW Groot Solar PV Park at the Groot Glass manufacturing facility is, as of 2023, currently under construction, having been delayed at the permitting and funding phases. It is expected to reach completion in 2024 and will be used for local electricity supply with the 12MW surplus being fed into the NamPower grid.

Construction of the 90MW solar hydrogen power plant in Swakopmund in the southwest, at a cost of USD $170 million, will cater for the decentralised demand here, reducing demand from South African imports, which have declined due to the plummeting power generation and restructuring of Eskom.

In November 2022, the Rosh Pinah 70MW power plant received ministerial approval, and construction by NamPower has begun. Initially, the plant was planned to generate 40MW from wind power, but an 18-month energy yield assessment and a marginal project viability re-evaluation ruled out construction of the wind farm, owing to declining potential yields. The project is funded by NamPower and planned as an Engineering Procurement and Construction (EPC) project. After consenting to the change in technology, NamPower is expected to begin sending out requests for proposals in the fourth quarter of 2023, before awarding a contract by the end of the second quarter of 2024. Construction will then commence, before commercial operation begins by the end of the third quarter of 2025.

Outapi Solar PV Farm generates at least 5MW (9,425 MWh) annually, against an installed capacity of 8.5MW, catering for the demand of at least 3000 beneficiaries. The project was initiated by Camelthorn Ventures, a Namibia-based company which later sold the plant to Innovent, a French-registered independent company in 2020. Innovent intends to double the solar farm's production capacity by installing additional solar panels, to attain 8.5MW by 2025.

In its effort to become a net exporter of electricity to the SAPP, through the ECB, Namibia granted Sanchou Energy a license to generate from solar and export 125MW of electricity through South Africa, under the modified Single Buyer (MSB) Framework. Once completed, the project would realise 116MW. It has USD $105 million in funding and is due to operate for 25 years in Karasburg, Namibia. It is funded by Emerging Markets Energy Services Company (EMESCO). The Ejuva Solar PV projects, Ejuva I and II, are the first twin solar projects to be constructed in Namibia. They are situated in the Omaheke Region, in land once considered idle. Each park has a capacity of 5MW, thus supplying at least 10MW of green electricity for 18,000 households. The projects are overseen by CiGenCo, a Mauritian company that specialises in investing, developing and operating power-generating plants in the region.

Construction costs have declined in Namibia's solar market, from $6.3/kWh in 2016 to $ 2.9/kWh in 2020[6]. This occurred organically, without any risk mitigation or government intervention, although a number of local market and operational factors are relevant here. Firstly, all renewable energy projects for utility scale solar PV are local currency denominated, reducing currency exchange fees. Secondly, the use of renewable energy auctions as the vehicle for project development procurement sets Namibia apart, allowing it to achieve lower cost owing to competition between bidders, unlike the feed-in tariff system and direct negotiations, whereby the cost is determined by an administrative agency. Thirdly, the robust management and financial strength demonstrated by Nampower, in contrast to other struggling utilities in the region, attracts more high calibre bidders enticed by the long-term sustainability of their projects. The ensuing competition forces reductions in bid prices which makes projects less costly, and serves the political goal of reducing power prices, which have risen sharply owing to higher import costs from South Africa and SAPP countries. Finally, recent years have seen declining costs in solar technology and the proven availability of resources to be harnessed. That said, acquiring land for setting up solar farms and other renewable energy projects does incur significant costs due to payments required for resettlements, rights of use changes and wayleaves.

[6] To find more about declining solar connection cost see, *A quiet transition: The role of Namibia's state-owned power utility in the renewable energy auction program*, Wikus Kruger, Utilities Policy, Volume 78 (2022).

Biomass energy

In the northern areas of the country, much of Namibia's bioenergy potential lies in the use of bush encroachment vegetation. Bush encroachment is seen as a major economic and ecological threat in Namibia, as wooded bush and shrub species spread rapidly across areas that were previously grasslands. Current estimates for the bush encroachment see up to 450,000km^2 of land being affected and growth rates of 3.2% (1.4 million hectares) per annum.

The ecological damage of bush encroachment includes the depletion of productive grazing and agricultural lands, dewatering of soils, and reduced biodiversity. It is thought that an imbalance between grazers and browsers, suppression of bush fires, overstocking of pasture lands and prolonged drought periods have spurred the densification and spread of these wooded species. Economically, the reduction in agricultural productivity alone is estimated to cost the country NAD $2 billion annually, in addition to the losses incurred in the tourism sector as the bush encroachment impairs and hinders the movement and identification of wildlife.

Bush encroachment can be reduced through bush thinning, which involves selective removal of certain aggressive species to clear land for grazing and natural grassland. Current efforts for curbing bush encroachment are estimated at clearing 200,000 hectares per annum, or 14% of the annual encroachment rate of 1.4 million hectares.

Historically, arboricides have been used to chemically combat the encroaching species, but recently considerable interest has been placed on the biomass potential of this resource: charcoal production and the use of bush wood chips for thermal and electrical energy is gaining momentum. Charcoal production is a well-established industry in Namibia, which exports 210,000 tons of charcoal per year, making it the fifth largest market worldwide. Only 10% of Namibia's biomass potential is currently harvested, however, primarily for charcoal production and increasingly for the material use pathway (animal feed, biochar).

Ohorongo Cement and Namibia Breweries have begun using wood chips to partially meet their thermal energy requirements. The benefits of switching to wood chips from invading bush are multifold: switching away from fossil fuels such as coal significantly reduces carbon emissions; reliance on local energy sources improves Namibia's balance of trade; addressing the bush encroachment problem is ecologically beneficial; and sourcing and supplying wood chips creates jobs in rural areas.

The use of biomass for electrical energy is also receiving attention in Namibia, both privately and publicly. The 400KW waste-to-energy plant in Ondangwe is in advanced stages as the Otjiwarongo Municipality floated an expression of interest (EOI) in April 2023 for eligible consultants to provide technical advisory services for the development of wastewater treatment plant and to produce electricity and fertiliser through a public private partnership (PPP). The plant construction is planned for completion by September 2025, serving a population of 45,000 with improved sanitation and new power generation. The population is projected to grow to 80,000 by 2040. The plant is expected to produce 3.4GWh of baseload electricity per year, mitigate 2,330 tCO_2e per year, and create 30 direct jobs.

The estimated biomass consumption of a 20MW biomass power plant is 180,000 tonnes, which would require approximately 18,000ha of land of encroaching bush to be thinned each year, assuming an energy content of around 8MWh/ha. Therefore, the bush encroachment resource in Namibia could

theoretically supply more than 70 of these 20MW power plants (1,400MW) for the next 30 years. The NIRP, however, estimates the national biomass potential as 600MW. NamPower is constructing a 40MW Otjikoto biomass power plant near Tsumeb, which is intended to catalyse private sector investment for other plants through IPP models in areas experiencing bush encroachment. These plants can be explored as a means of decarbonising the electricity sector: NamPower's project could mitigate 500,000 tCO2e. Harvesting biomass is planned for a radius of 100km. The sustainable harvesting yield for dry matter is 12.65 tonnes per ha, meaning 46.7 million tonnes of biomass available within the harvesting site. The plant has an annual fuel requirement of 201,370 tonnes of biomass, which equates to 10.8% of the encroacher bush, over the 25 years of the plant's lifespan. The project documents indicate that it will spend USD $134 million and is due for commissioning by August 2023.

Bioenergy from specially cultivated crops is not being considered, due to the competition that it would have with food crops over land.

Wind energy

According to the most recent NIRP, Namibia has enough wind resources for large-scale wind power projects. It was estimated that Namibia's wind resource potential was around 300MW, and is most concentrated along the western coastline, particularly in the southwest.

The only project that reached financial close under the REFIT programme that was not a solar PV plant was an onshore wind project in Luderitz, with a generating capacity of 5MW and a predicted capacity factor of 40%. The project was synchronised with the grid in December 2018 and was developed by Innosun Energy Holding. NamPower has signed another PPA and a Transmission Connection Agreement (TCA) for the development of a 50MW wind power plant in the town of Luderitz, Southwest Namibia, by CERIM Luderitz Energy. The project is expected to cost USD $96.4 million, with a 27-month construction period, before being synchronised with the grid in July 2025. This project was part of the two wind farms that were to be constructed, to generate a cumulative 90MW. However, upon re-evaluation and confirmation of bankable data, the 40MW wind farm was deemed not viable and instead converted to a solar farm.

External to the REFIT programme, NamPower has signed a power purchase agreement (PPA) with Diaz Wind Power, another large-scale wind project near Luderitz. The project will have a capacity of 44MW, making it the largest renewable energy power plant in the country (excluding hydro). In January 2020, the Diaz Wind Power project was allocated land from the Ministry of Environment and Tourism. Construction began in December 2022 and is expected to conclude by May 2024[7]. Plans are in place to expand this project to 90MW if the project is able to demonstrate its success at 44MW.

Green hydrogen

As the world gears up to the prospects of energy generation from hydrogen, Namibia's potential means that it, too, is taking a stake in this opportunity. According to model projections, a kilogram of green hydrogen can be produced for NAD $25- 33 NAD ($1.42- $1.87). Close ties with Germany have enabled Namibia to obtain funding from the German Federal Ministry of Education and Research for development of this new sector. In November 2021, the Namibian Government awarded a tender to The

[7] For detailed information on the Diaz wind project's progress, see page 5 of NamPower's Luderitz wind power plant project fact sheet.

Hyphen Hydrogen Energy consortium, including Enertrag, a German-based company aiming to realise the vertically integrated hydrogen project near Luderitz. The build-up stage of the 2GW renewables (wind and solar) is expected to commence production of hydrogen in 2026. By the end of 2030, 5GW of renewables (solar and wind) and 3GW of electrolysis are to produce 300,000 tons of green hydrogen and 2 million tons of green ammonia at an investment cost of around $9.4 billion[8].

National Renewable Energy Policy

The Namibian Government published the 2017 National Renewable Energy Policy to bolster Namibia's renewable energy development and ratify its commitment to a clean energy future. It is aligned to and supportive of existing national policies, regulations and frameworks, including the National Energy Policy, the NDP, the Electricity Act (2007), the Rural Electricity Distribution Master Plan (2010) and the Off-Grid Energisation Master Plan (2007), among others.

The National Renewable Energy Policy aims to enable access to modern, clean, sustainable and affordable energy through grid-supplied, off-grid and distributed solutions. If successful, Namibia will become a regional leader in the development and deployment of renewable energy.

In pursuit of this vision, the National Renewable Energy Policy outlines the following key objectives:

- Ensure 70% of the population has adequate and affordable energy access by 2020 and near-universal access by 2030.
- Make renewable energy development a national priority.
- Undertake and implement supportive measures, such as financial incentives or enabling mechanisms, to spur renewable energy deployment and attract investment in the sector.
- In addition to lending and tax support to renewable energy developers, prioritise training and capacity building for Namibian citizens in this sector to enable greater participation.
- Bridge the energy import deficit wherever it makes economic sense to do so.
- Aim for 70% of electricity generation (as kWh) in 2030 to come from renewable energy sources.
- Recognising that some regions in Namibia may be optimally supplied with electricity through off-grid solutions, balance the development of both grid-connected and off-grid renewable energy development by identifying locations where off-grid solutions are better suited through periodic, evidence-based and community-engaging evaluations.
- Through diversification of the energy mix (including non-electricity energy sources) towards renewable sources, the energy sector will contribute meaningfully to the achievement of the Intended Nationally Determined Contribution (INDC) submission's target of an 89% emissions reduction by 2030.

The role of mini-grids in achieving universal electricity access in Namibia has been cited in the National Renewable Energy Policy of 2017[9]. Electrifying all households through a centralised grid is not the most practical and cost-effective solution in Namibia, and off-grid or distributed energy solutions that do not compromise quality or reliability will be required to meet the universal electrification target.

[8] For more on plans for green hydrogen in Namibia see the sector brief of Namibia: Renewable Energies by visiting https://www.giz.de/en/downloads/giz2022-en-sector-brief-namibia-renewable-energy.pdf

[9] For detailed information on the role of mini-grids to enhanced electrification, see page 36 on rural energy and mini-grids in the National Renewable Energy Policy (2017).

Namibia already has experience with off-grid and mini-grid systems, as demonstrated by the Tsumkwe Energy Project, a 200kW solar hybrid system developed in partnership with the Desert Research Foundation of Namibia. In addition to installing the electricity-generating equipment to provide power to the community, streetlights, rechargeable electric lanterns and a solar kiosk were installed to extend the benefit of this electrification project beyond just power supply.

Table 3. Active support programmes in Namibia

Programme	Main activities
Southern African Sustainable Energy Initiative (SASEI)	A regional project focused on developing capacity in the higher education institutions of partner countries for national and regional planning, development and implementation of sustainable energy systems and projects. It is coordinated by the Namibia University of Science and Technology, in partnership with the University of Lesotho, the University of Botswana and Hochschule Darmstadt in Germany.
Scaling up the Africa Clean Energy Corridor (ACEC)	The SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), headquartered in Windhoek, has partnered with IRENA to accelerate the expansion of renewable electricity production, taking advantage of the continent's enormous untapped potential and helping to sustain future growth through renewable power development zoning, planning processes, enabling mechanisms, capacity building and public information.
Gender Mainstreaming and Women in Sustainable Energy Program	This programme helps increase access to modern, affordable, and reliable energy services, energy security and environmental sustainability by tailoring national and regional policies, projects and programmes to the energy needs of both men and women. It also aims to foster women's economic empowerment through sustainable energy access.
Renewable Energy Feed-in Tariff Program (REFIT)	In 2015, the Namibian government implemented the REFIT programme to procure biomass, solar PV and wind energy projects between 500kW and 5MW in size. To date, this programme has managed to secure 14 power purchase agreements (PPAs) with the IPPs, predominantly using solar PV (13 projects) and one using wind. The National Renewable Energy Policy has recommended that Namibia continue with the REFIT programme structure for projects under 5MW, but to shift towards an auction-based, competitive bidding system similar to that in South Africa for projects over 10MW, which could see the development of a renewable energy auction programme in the future. Through the programme, an additional 55MW of capacity has been achieved, with an additional 15MW expected after completion of three solar parks, each having a capacity of 5MW in Okatope.
The Off-Grid Energisation Master Plan (OGEMP)	The OGEMP was published in 2007 and is a 20-year programme to provide access to appropriate energy technologies to areas not serviced by the grid. The underlying objective of the OGEMP is to provide access to appropriate energy technologies to everyone living or working in off-grid, pre-grid and in-between areas. The approach through which these areas would be electrified was using 'energy shops' in off-grid communities that would sell approved, suitable energy products, particularly renewable energy products, to community members. Additionally, consumer credit finance would be provided through revolving funds, such as the Solar Revolving Fund (SRF), which offers concessional loans to households to improve affordability of these energy products. In a recent report to Parliament, the Assistant Minister for Mines and Energy reported that 400 households were electrified through the project in the year 2022/2023, at a cost of $ 643,123. In the year 2023/2024, the fund has been increased to $2.89 million, which aims to electrify 78 public institutions, meaning schools and clinics, and at least 180 households. Some of the challenges that the programme faces are the low recovery rates of loans, and a lack of sufficient installers and technicians to repair the solar kits in the off-grid areas.

Table 3. Active support programmes in Namibia

Climate Resilient Agriculture in three of the Vulnerable Extreme northern crop-growing regions (CRAVE)	The aim is to increase climate-resilience and reduce food insecurity for subsistence farmers in Namibia. CRAVE will reduce food insecurity by enabling beneficiaries to adopt conservation and climate-resilient agricultural practices to produce food, as well as providing them with access to renewable energy in the form of off-grid solar energy technologies for water pumping, refrigeration and domestic uses.
Adaptation Fund: Water desalination plants using renewable power	The objective of the project is to pilot the treatment by reverse osmosis of poor-quality local groundwater to a level that complies with the national standards for drinking water, using sun and wind energy to power the process. The project will be executed by NamWater and will improve the resilience of vulnerable communities to the deleterious water supply and quality impacts that climate change is causing.
The Economics of Land Degradation (ELD) Initiative	The Economics of Land Degradation (ELD) Initiative is a global collaboration to evaluate and raise awareness of the economic benefits of land and land-based ecosystems. In 2017, the ELD-Initiative conducted a national economic study on the benefits of bush control for Namibia. The findings of the study suggest that a comprehensive programme of bush control and biomass utilisation could generate an estimated potential net benefit of USD $0.4 billion for the Namibian economy, compared to no action at all.
Southern Africa Renewable Energy and Energy Efficiency Strategy and Action Plan (REESAP)	Adopted in 2017 with an implementation period spanning until 2030, the REEESAP aims to provide a framework for SADC member states to develop their own renewable energy and energy efficiency strategies and action plans, leading to greater uptake of RE resources as well as mobilisation of financial resources for the sector. REEESAP will be implemented at the most appropriate levels by relevant agencies in the region and in member states, one of which is Namibia. SACREEE, which is headquartered in Windhoek, is the primary implementation body for this programme.
Green People Energy Project	Launched in 2022 under the Ministry of Mines and Energy's Solar Revolving Fund, supported by €330,000 from GIZ. This fund, however, targets low-income individuals such as rural micro enterprises operating retail shops, tailors, carpentry workshops, farming communities, poultry etc. The project aims to contribute to the goal of securing a cost-effective energy supply, attendant to the electrification of 6,000 rural households and 13,000 peri-urban households. This will reduce the number of rural communities not electrified, which currently amounts to 20% of Namibia.
The Informal Settlement Renewal Electrification and Upgrading Program	With USD $485,000 in funding from the African Development (AfDB) Bank's Urban and Municipal Fund (UMDF), from 2023, the Municipal Council of Windhoek is expected to upgrade critical services in its informal neighborhoods under the city's strategic plan. Through installing electricity in informal settlements, it is expected that the economic potential of those neigbourhoods will be tapped for economic prosperity, addressing social and economic marginalisation through poverty reduction. 200,000 people around Windhoek (20% of this population) will benefit. Numerous projects are ongoing, including feasibility studies, tender for installation of a 60MW solar PV and batteries, the development of an overall structural plan for the rehabilitation of an informal settlement, and institutional support to the Municipal Council of Windhoek.
SteamBioAfrica	This is a collaboration involving both Africa and Europe, with the objective of enabling long-term sustainable benefits across Namibia, Angola and Botswana. This is informed by the need for clean, secure and reliable energy, as well as need to address the challenge of the encroacher bush and other invasive biomass species. With funding from the European Union, the project intends to produce 250kg/hour of clean burning, high-value coal substitute. The demonstrator project runs from September 2021 to August 2024 at a cost of €11,725,328.75, of which the EU funding was €9,937,771.26. It benefits cheetah and other wildlife conservation projects in the region as well.
Pathway to Renewable Off- Grid Community Energy for Development (PROCEED)	This is a joint German-Namibian project funded at €1,246,892 from April 2019 to the end of September 2023. The project aims to develop sustainable models for the creation of island networks, to cater for populations in remote areas that lack access to a reliable infrastructure. Hybrid energy systems will be designed to link the technological, social, economic and environmental elements of energy supply. Various aspects of mini-grid

Table 3. Active support programmes in Namibia	
	deployment are being explored: mini-grid communities, mini-grid economics, mini-grid technology and mini-grid sustainability. Some of the research conducted by the University of Bayreuth as part of the consortium led by Ingolsdat University includes a cost-covering tariff and payment system for centrally organised hybrid energy that is based on renewable energy. PROCEED works to realise energy transfer and strengthening of the network of actors at the German, Namibian and Southern Africa Development Cooperation (SADC) region.

Industry associations

The **Renewable Energy Industry Association of Namibia** (REIAoN) has been established to promote renewable energy and educate stakeholders on renewable energy technologies. It will also represent the renewable energy industry in Namibia for workshops and government liaison and communications, and will lobby for renewable energy uptake in Namibia.

Namibia Petroleum Operators Association (NAMPOA) is a forum representing all oil and gas exploration companies operating in Namibia and enables effective communication on vital issues to key stakeholders, including the Government of Namibia.

Regional Electricity Regulators Association of Southern Africa (RERA) is a sub-organisation of SADC for the cooperation of their national electricity and energy regulatory authorities. The Secretariat is located in Windhoek. The main objective of RERA is to facilitate the harmonisation of regulatory policies, legislation, standards and practices. It serves as a platform for effective cooperation among energy regulators within the SADC region. The member from Namibia is the Electricity Control Board (ECB).

Association of Consulting Engineers of Namibia (ACEN) offers collective representation for consulting engineers. ACEN seeks to promote best practice and professionalism in the industry and advance the profession of consulting engineering in Namibia. It was established in 1982, and membership has grown to 55 firms with 400 employees between them.

The Namibian Manufacturers Association (NMA), established in 1994, aims to facilitate a sustainable, competitive and prosperous manufacturing and processing industry for the benefit of all stakeholders. This is to be achieved through close cooperation with government departments, industries and interested parties.

Namibian Biomass Industry Group (N-BiG) draws membership from the public and private sectors, as well as academics active in the bush encroachment sector. The group drives innovation and technology development, and offers technical expertise on biomass value chains. It explores market opportunities, promoting industry diversification and capacity building for sustainable bush control and biomass utilisation.

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Useful contacts

British High Commission, Windhoek
https://www.gov.uk/world/organisations/british-high-commission-windhoek
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Namibia Investment Centre
http://www.mti.gov.na/nic.html (site under construction)
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Electricity Control Board
http://www.ecb.org.na/index.php
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Ministry of Environment, Forestry and Tourism
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