The MSAP Project

Mozambique-South Africa Power Generation & Transmission project

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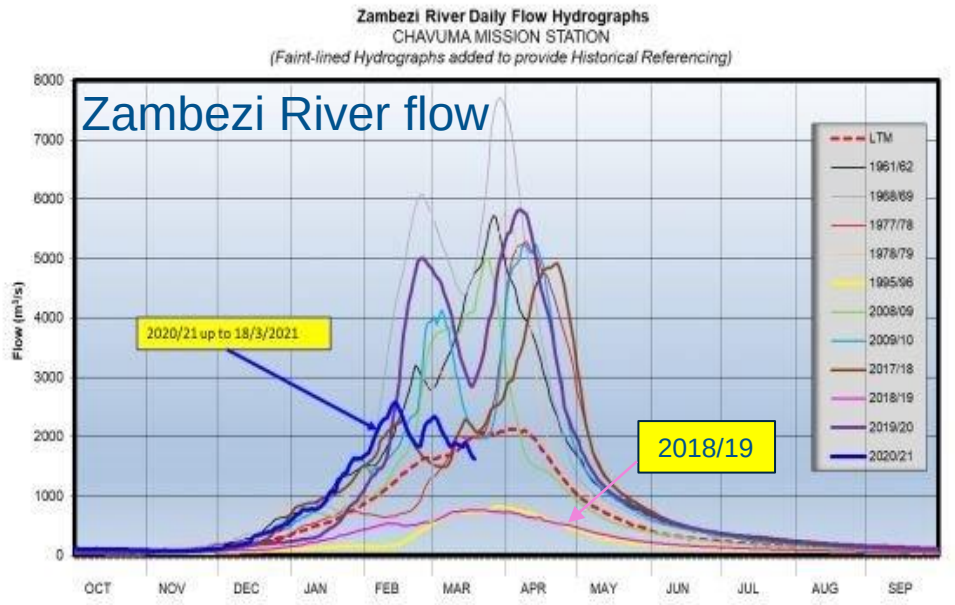
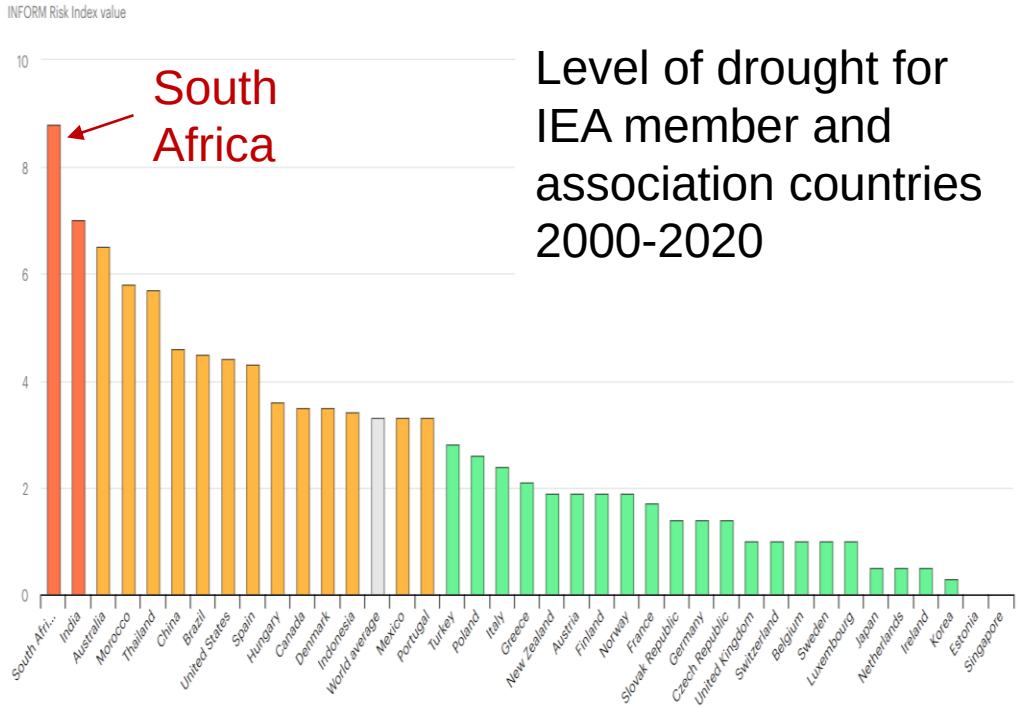
ÇALIK ENERJİ

Linden STRATEGIES

THE CHALLENGE





Level of drought for IEA member and association countries 2000-2020

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The southern African electricity landscape

Cyril Ramaphosa, President of South Africa

Filipe Nyusi, President of Mozambique

South Africa

- South Africa's aging coal-fired power stations are in poor condition and highly polluting. A new supply of electricity is urgently required.
- Industry in South Africa has suffered greatly due to shortages of electricity in recent years and would welcome an alternative supply.
- Climate change leading to drought has put hydropower as a reliable low carbon power source in doubt.

Southern African Development Community (SADC)

- Generation and consumption of electricity varies greatly across Southern Africa, with many countries importing most of their requirements.

Mozambique

- Enormous natural gas resources have been discovered offshore northern Mozambique
- The country is projected to see significant economic growth which will result in increased requirements for power.
- The large LNG facilities proposed and being constructed require significant amounts of electricity to function.

CCGT technology offers a highly efficient and low GHG-emission generation solution to the growing power demand in Mozambique and the region.

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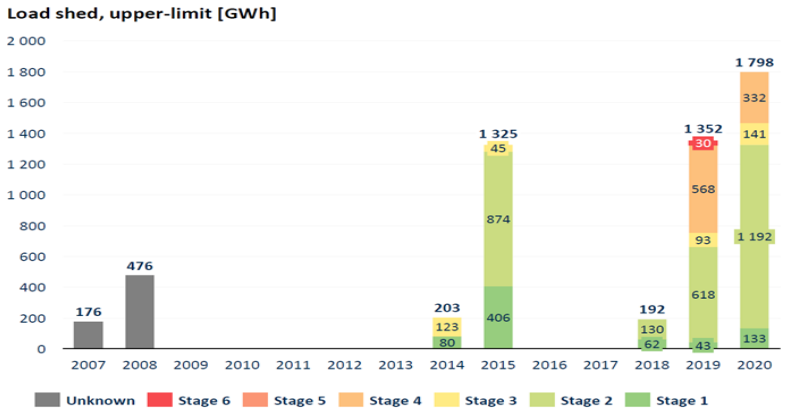
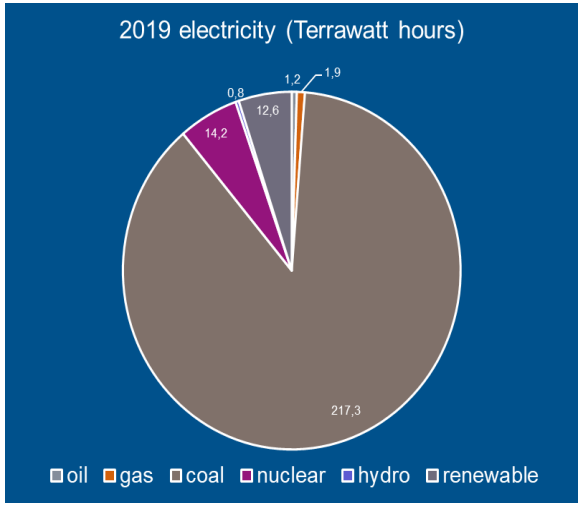
Power outages

- Eskom continues to be unable to meet electricity demands in South Africa.
- Load-shedding remains a fact of life for everyone.



- Coal currently provides >80% of all power in South Africa, one of the highest proportions in the world.



South Africa's 2020-2030 Plan (IRP 2019)

	Coal	Coal (Decommissioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel	Other (Distributed, CoGen, Biomass, Landfill)
Current Base	37149		1860	2100	2912	1474	1980	300	3380	499
2019	2155	-2373					244	300		Allocation to the extent of the short term capacity and energy gap
2020	1433	-557				114	300			
2021	1433	-1403				300	818			
2022	711	-844			513	400 1000	1600			
2023	750	-555				1000	1600			500
2024			1860				1600		1000	500
2025						1000	1600			500
2026		-1219					1600			500
2027	750	-847					1600		2000	500
2028		-475				1000	1600			500
2029		-1694			1575	1000	1600			500
2030		-1050		2500		1000	1600			500
Total Installed Capacity by 2030 (MW)	33364		1860	4600	5000	8288	17742	600	6380	
% of Total Installed capacity	42.87%		2.39%	5.91%	6.42%	10.65%	22.79%	0.77%	8.20%	
% Annual Energy Contribution	58.80%		4.50%	8.40%	1.2%*	6.30%	17.80%	0.60%	1.30%	

Installed Capacity
Committed/Already Contracted Capacity
Capacity Decommissioned
New Additional Capacity
Extension of Koeberg Design Life
Includes Distributed Generation for own use

- South Africa has committed to decommissioning over 30% of current coal capacity in the coming decade.
- In excess of 20GW of new power is urgently required

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Climate Change

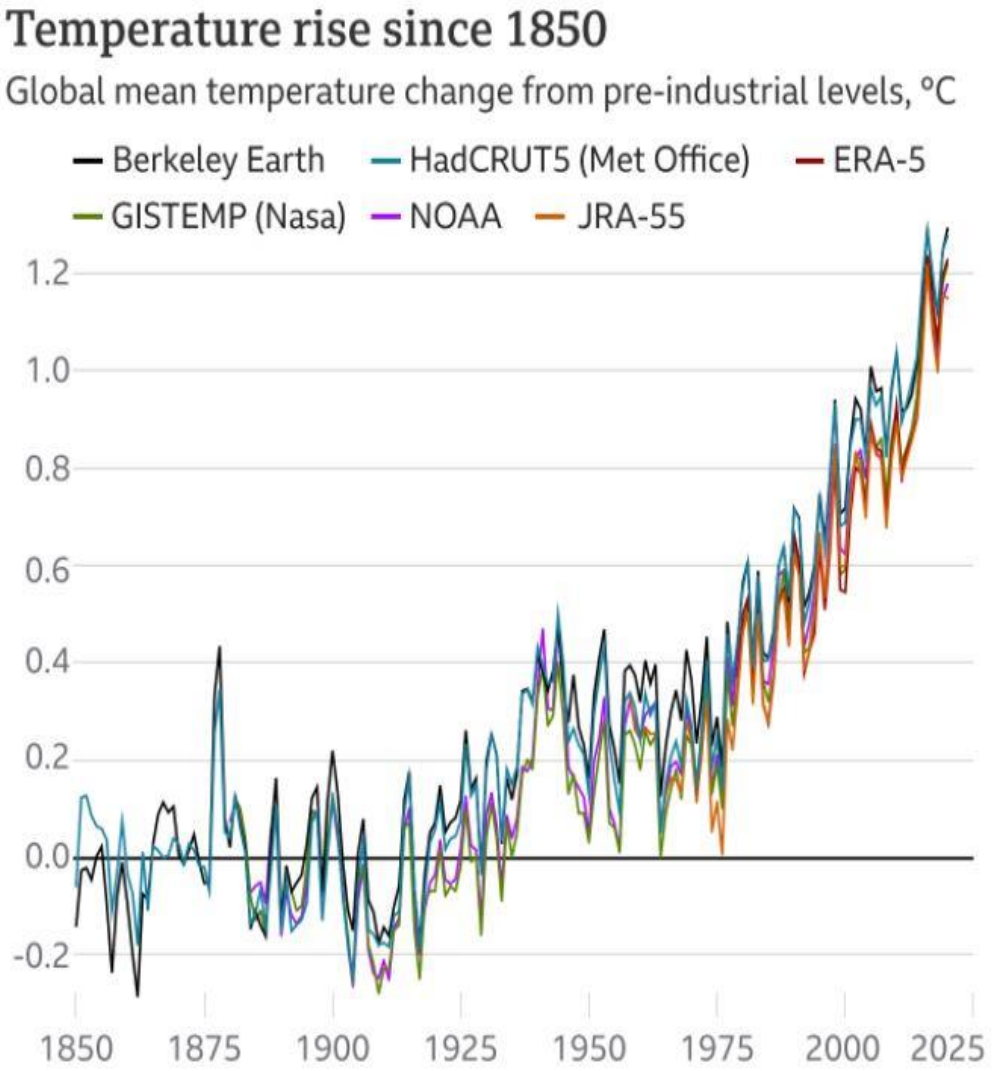
Climate Change is a worldwide problem also affecting Southern Africa.

Worldwide temperatures have increased 1.2 deg C in past 100 years with similar rise in South Africa.

Climate change leading to drought has put hydropower as a reliable low carbon power source in doubt .

Eskom, the South Africa power monopoly has the highest CO2 emissions of any company in the world.

At .05 deg. C/yr. South Africa is warming at 65% higher than world average



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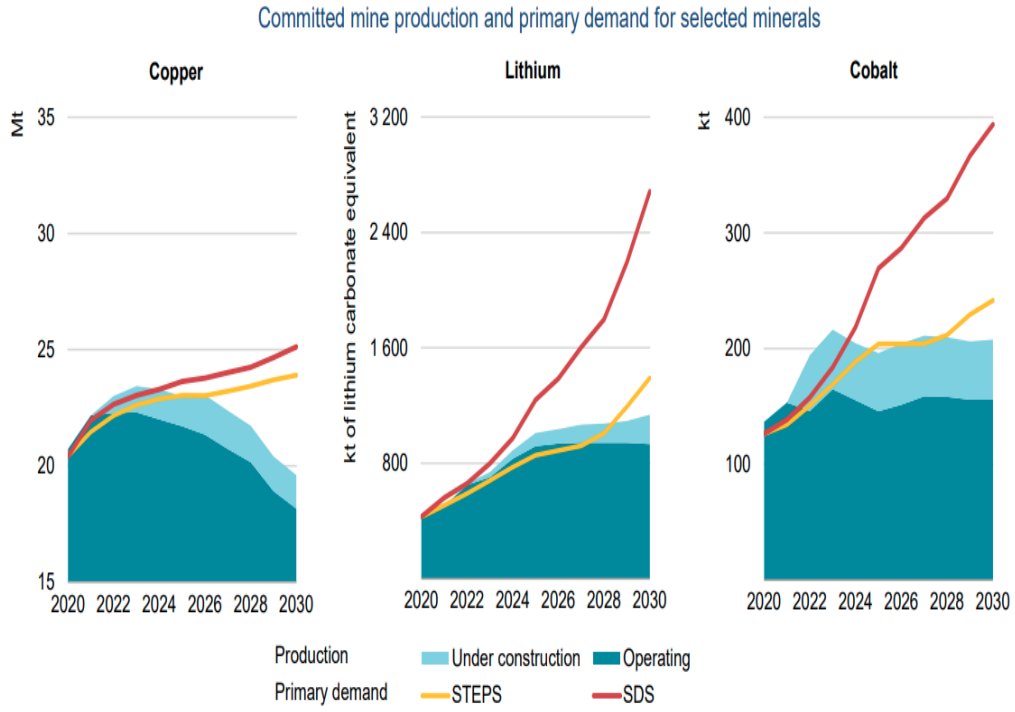
Impending worldwide shortages of renewable minerals

The world is desperately short of minerals needed for renewable production. Investment needed for production has not increased in the past 5 years which will lead to shortages in the coming decade

Lead time of 10-15 years needed from investment decision to production for major minerals projects

Meeting primary demand in the SDS requires strong growth in investment to bring forward new supply sources over the next decade



SDS: IEA Sustainable Development Scenario leading to net zero by 2070

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THE SOLUTION

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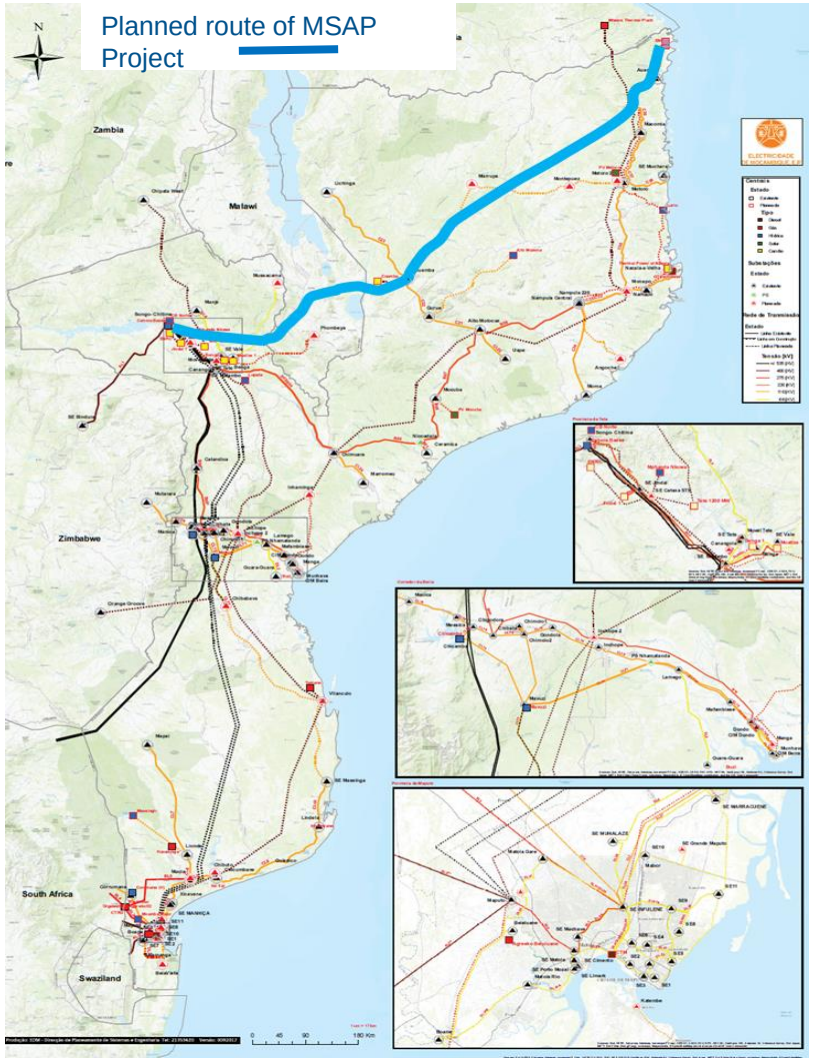
MSAP concept, Route, Phases and Timing

- Construction of ~2.3GW high efficiency CCGT plant adjacent to the LNG plant facility to provide electricity to facilitate economic growth in northern Mozambique and to the Southern African Power Pool to generate export income.
- Gas to be sourced from the significant discoveries offshore Rovuma though domestic market obligations or from Block 1 and/or Block 4 Joint Ventures.
- Construction of a 1090 km 2GW HVDC power line from the LNG facility area to the Songo HVDC station following the Nacala Logistics Corridor through Malawi.
- Upgrade of HVDC rectifier at Songo to increase existing line capacity to 3960MW – Apollo inverter already upgraded.
- Construction of 500km AC lines at LNG facility and Songo for local power distribution in NE Mozambique and Malawi.



Following completion of initial project in 2025, option to complete second power plant, increasing capacity of Mozambique HVDC line to 4 GW and Cahora Bassa line to 6 GW or 2 GW line to DRC (2025-27)

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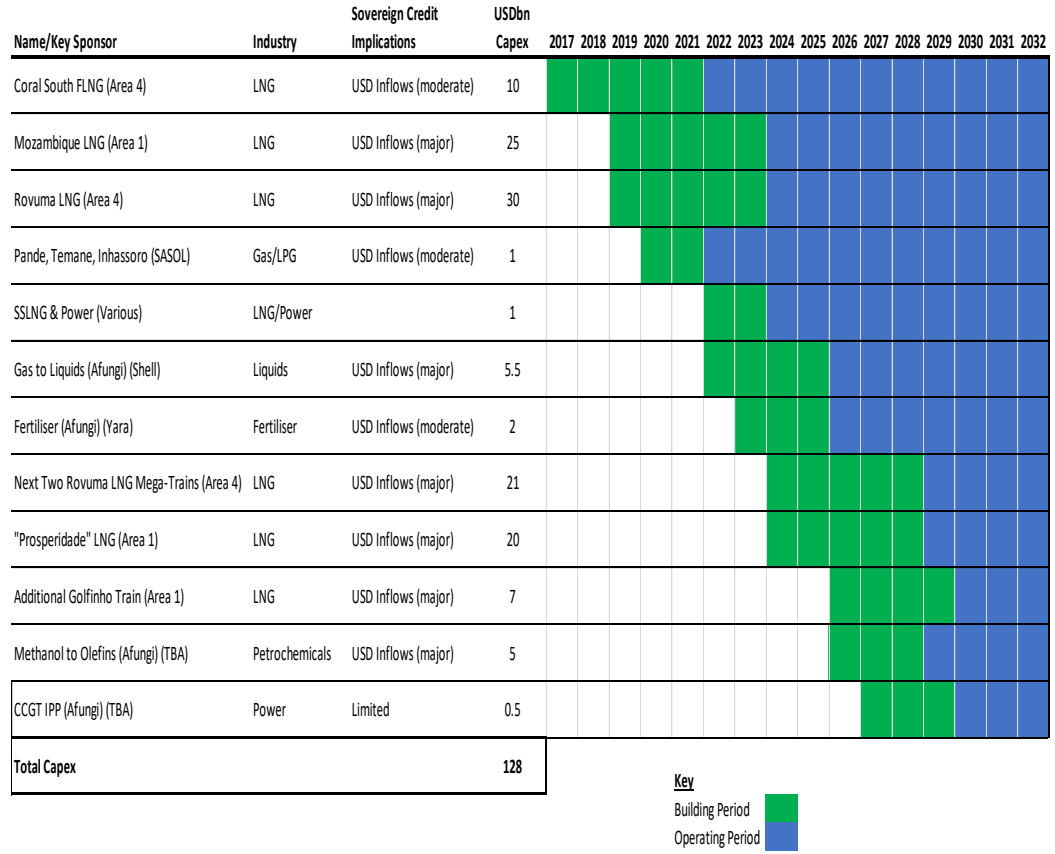
Abundant low-cost Gas Supply and market for electricity

- Approximately 120 TCF (3.4 TCM) discovered offshore northern-most Mozambique
- Three LNG projects initiated:
  - Onshore **Mozambique LNG**, 12.9 MMT/yr. capacity (620Bcf/yr) start-up 2024;
  - **Onshore Rovuma LNG**, 15.2 MMT/yr. capacity (730Bcf/yr) start-up 2025;
  - Offshore **Coral FLNG**, 3.4 MMT/yr. capacity (160Bcf/yr) start-up in 2022.
- Additional gas required for the **2GW MSAP** project is **90Bcf/yr**, less than 6% of the total, requiring only additional wells to be drilled even when extended to 4GW
- Additional petrochemical facilities expected, following initiation of onshore of LNG (GTL, fertilizer, methanol to olefins) all requiring significant power supply.

Name/Key Sponsor	Industry	Sovereign Credit Implications	USDbn Capex
Coral South FLNG (Area 4)	LNG	USD Inflows (moderate)	10
Mozambique LNG (Area 1)	LNG	USD Inflows (major)	25
Rovuma LNG (Area 4)	LNG	USD Inflows (major)	30
Pande, Temane, Inhassoro (SASOL)	Gas/LPG	USD Inflows (moderate)	1
SSLNG & Power (Various)	LNG/Power		1
Gas to Liquids (Afungi) (Shell)	Liquids	USD Inflows (major)	5.5
Fertiliser (Afungi) (Yara)	Fertiliser	USD Inflows (moderate)	2
Next Two Rovuma LNG Mega-Trains (Area 4)	LNG	USD Inflows (major)	21
"Prosperidade" LNG (Area 1)	LNG	USD Inflows (major)	20
Additional Golfinho Train (Area 1)	LNG	USD Inflows (major)	7
Methanol to Olefins (Afungi) (TBA)	Petrochemicals	USD Inflows (major)	5
CCGT IPP (Afungi) (TBA)	Power	Limited	0.5
Total Capex			**128**



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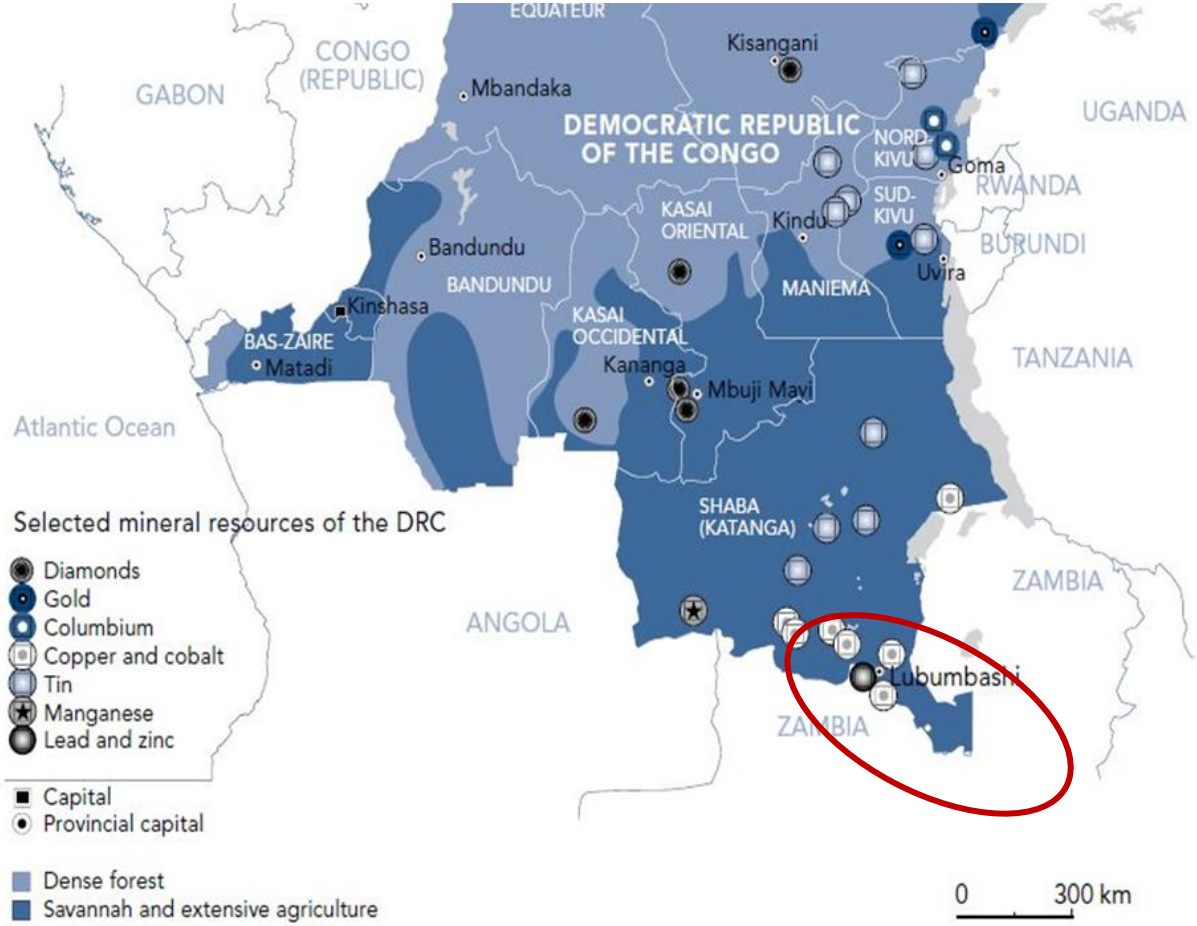
DRC – unserved power demand and badly needed minerals for renewables

- The IEA's Sustainable Development Scenario sees strong growth in demand for minerals used in renewables, storage and electrification of transport.
- The copper belt of the DRC holds significant resources of many of these minerals but lack of power is a significant impediment to growth of mining operations in Katanga Province.
- Future demand from creditworthy entities is estimated at 4GW.
- The Southern African Power Pool (SAPP) plans to build an interconnector from Mozambique to supply power to Zambia, where mining operations are also power constrained.
- MSAP could utilise this interconnector to bring initial MSAP power to Zambia and on to Katanga in the DRC.
- Future supply of 2 to 4GW could be accommodated through extension of the MSAP HVDC infrastructure directly from Songo in Mozambique.



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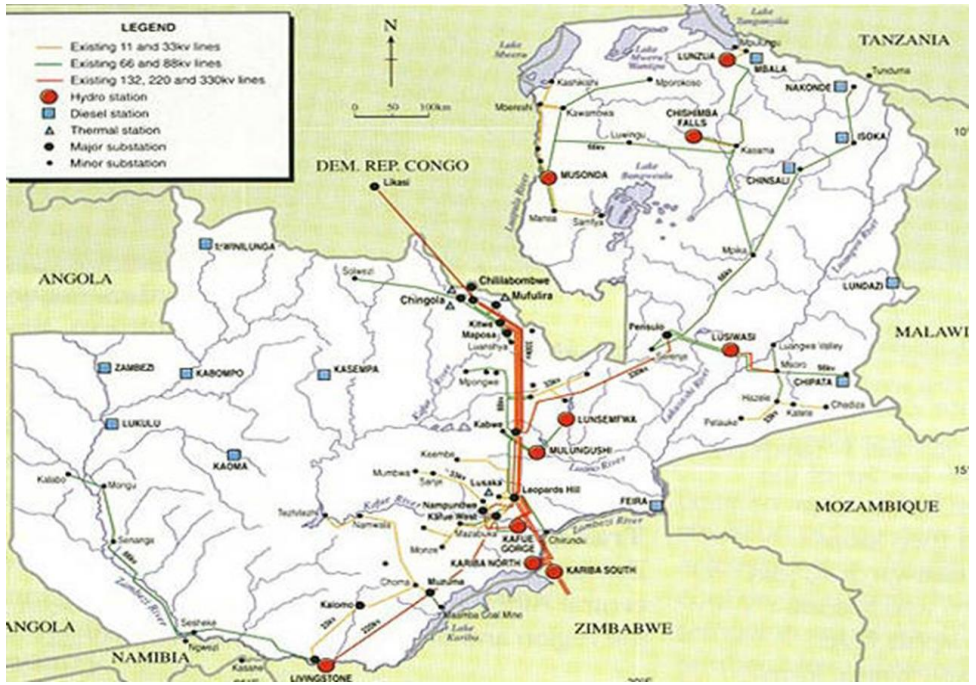
Mozambique-Zambia Interconnector

- The Mozambique - Zambia 400KV Power Interconnector Project includes a ~380km transmission line that connects Cahora Bassa Hydroelectric Power Station at Songo in Mozambique with the power system of Zambia at Serenje.
- Initial capacity is planned at 900MW
- Potential to upgrade initial plan to include 2GW HVDC line straight to Lubumbashi/Likasi.



- The existing grid in Zambia includes reasonably strong connections from Serenje through to Likasi in DRC
- Utilisation of the Mozambique-Zambia interconnector and the Zambian grid would allow sale of initial small quantities of electricity from MSAP to DRC.
- The feasibility study will include the option to build a strong HVDC line to Katanga Province as part of MSAP.

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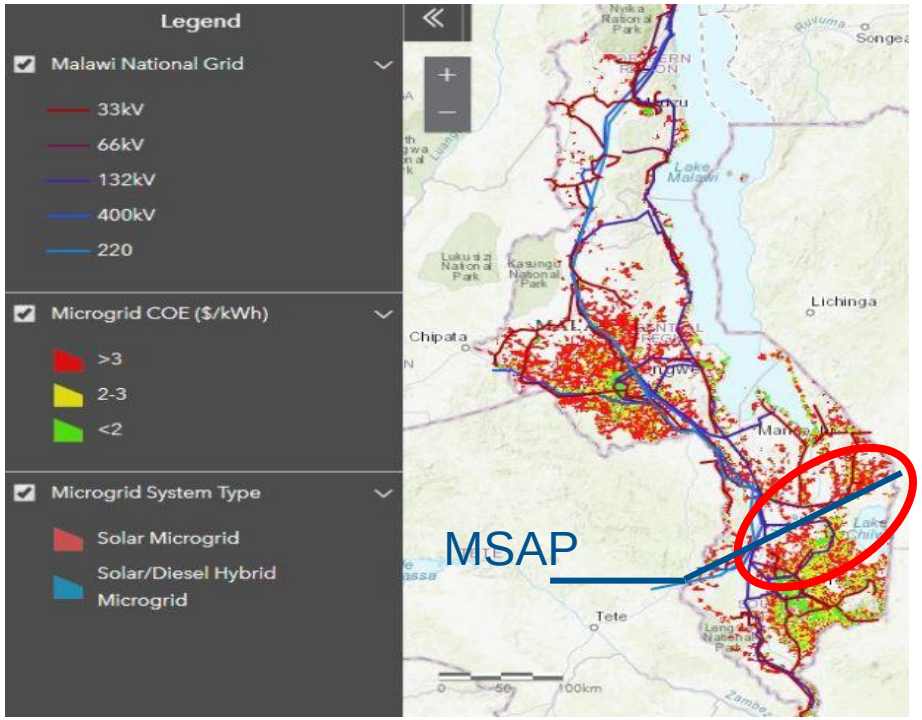
MSAP addresses Malawi Power vulnerability



- 439 MW installed power.
- 88% hydropower.
- Due to climate change, this source increasingly unreliable.
- Power needs greatest in highly populated southeast portion of country.

- Potential for AC line to supply power to Southern Malawi as reliable source to balance unreliable hydropower.
- Payment to Malawi in power instead of transit fees.

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Regional landscape and engagements

Mozambique - Ministry of Mineral Resources and Energy

- Ministerial support required for project to proceed.

Gas supply

- INP responsible for allocation from 25% domestic use obligation with LNG projects.
- Opportunity for ENH to monetize their share of produced gas from LNG projects.

Generation and transmission

- Close cooperation with EDM regarding partnership in project.

Malawi- Ministry of Natural Resources, Energy and Environment

- Engagement with Ministry regarding route, power supply and tariffs.

South Africa – transmission and sale only

Eskom: South Africa State Electricity Monopoly

- Engaged with COO to clarify future role of Eskom as it restructures.
- COO created Eskom project team to engage on MSAP
- Power purchase agreement to be negotiated.

US Government

- Presentation to USAID, DFC and DOE for possible designation as "Priority Project".

Calik

- World class project manager already working on similar type projects.
- Currently completing hydroelectric project in Malawi on projected route of transmission line.

THE BENEFITS

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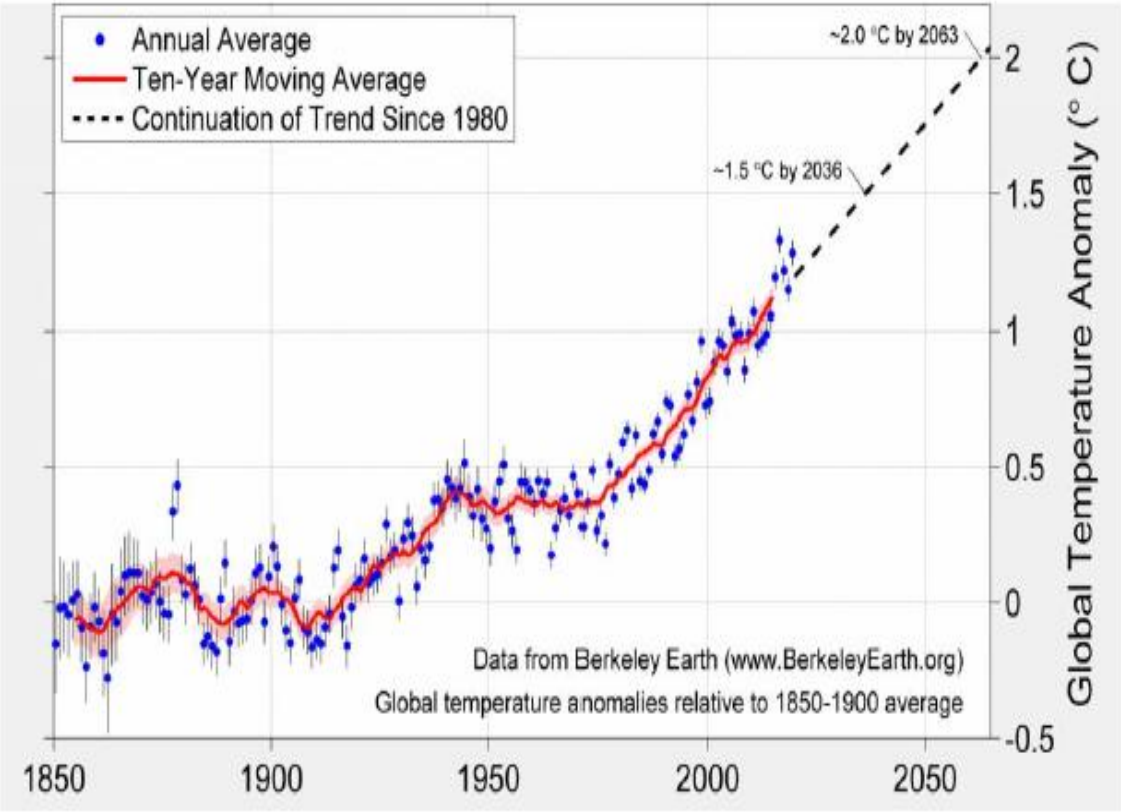
Climate Change and the MSAP Proposal



- Recognition of the impact of climate change has resulted in broad consensus that construction of coal fired power stations, heavily polluting and with the highest CO_2 emissions of all fossil fuels, should be avoided if any alternatives are available.
- Natural gas, the cleanest burning fossil fuel with the lowest CO_2 emissions, is recognized globally as the best substitute for coal and is available in abundance in Mozambique.
- The MSAP consortium propose to build a large and efficient natural gas power plant to replace Mozambique's planned coal generation capacity and optimize the gas-powered portfolio proposed in the Integrated Master Plan.
- The power plant has been designed to satisfy all of the projected demand in the northern provinces of Mozambique while exporting significant amounts of power to the Southern African Power Pool.
- Result will be estimated 4.5 MMT/yr. reduction in CO_2 emissions in the initial phase (2 GW power plant), with an 8.7 MMT/yr. reduction when expanded to a 4 GW project.
- **Adoption of CCS option would double reduction of CO2 emissions.**

The pre-feasibility study has been completed and demonstrates that the MSAP project is technically and commercially robust.

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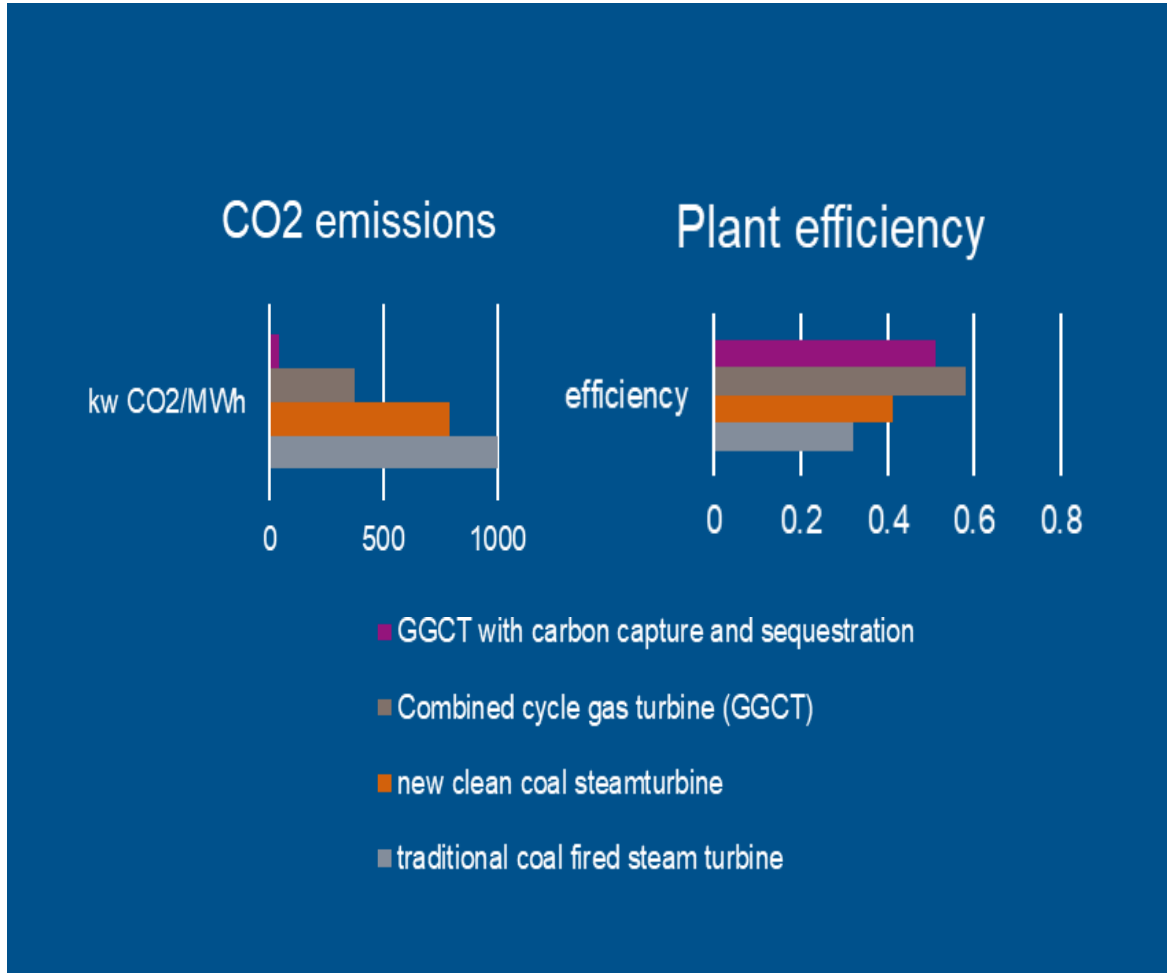
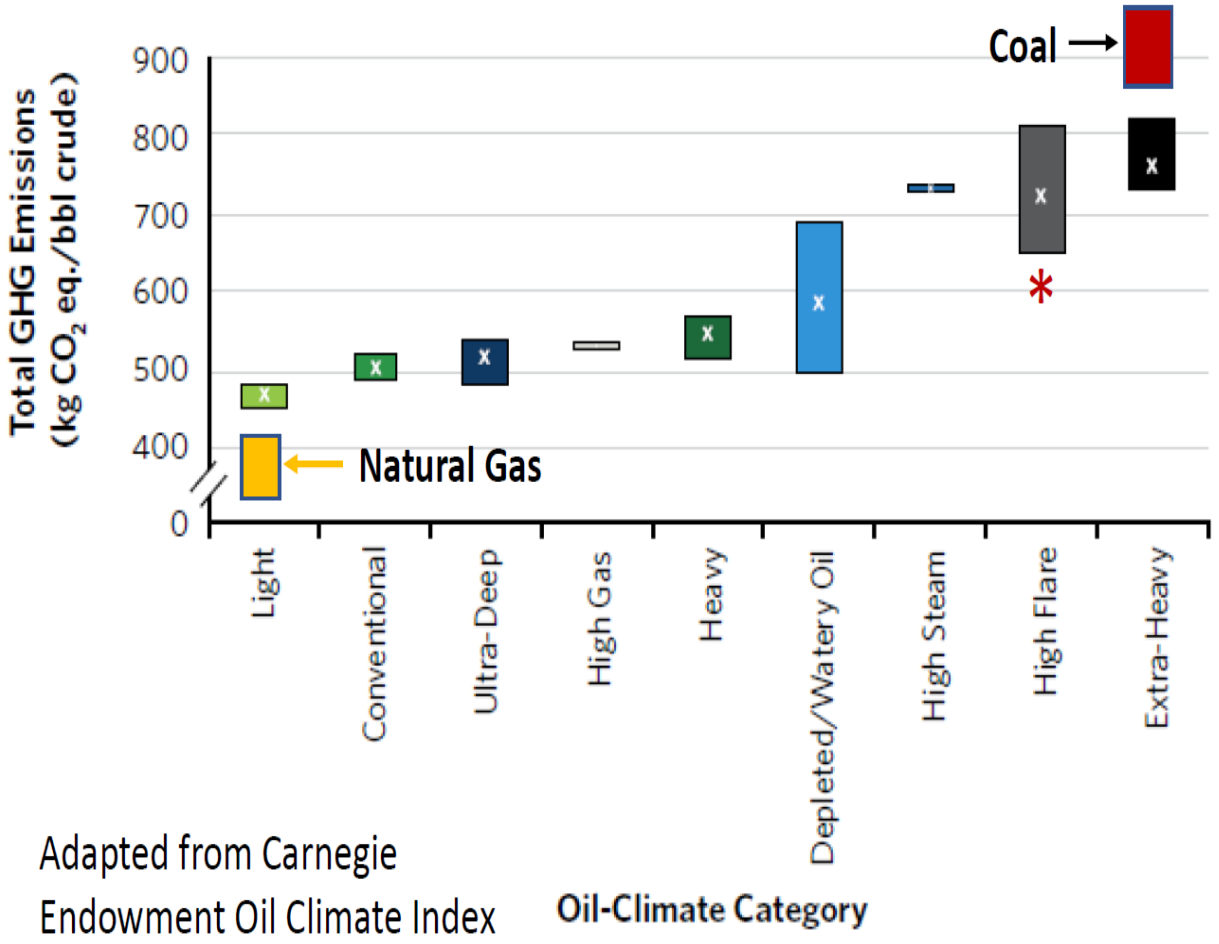
Climate Change and the MSAP Proposal





Adapted from Carnegie Endowment Oil Climate Index

The pre-feasibility study has been completed and demonstrates that the MSAP project is technically and commercially robust.

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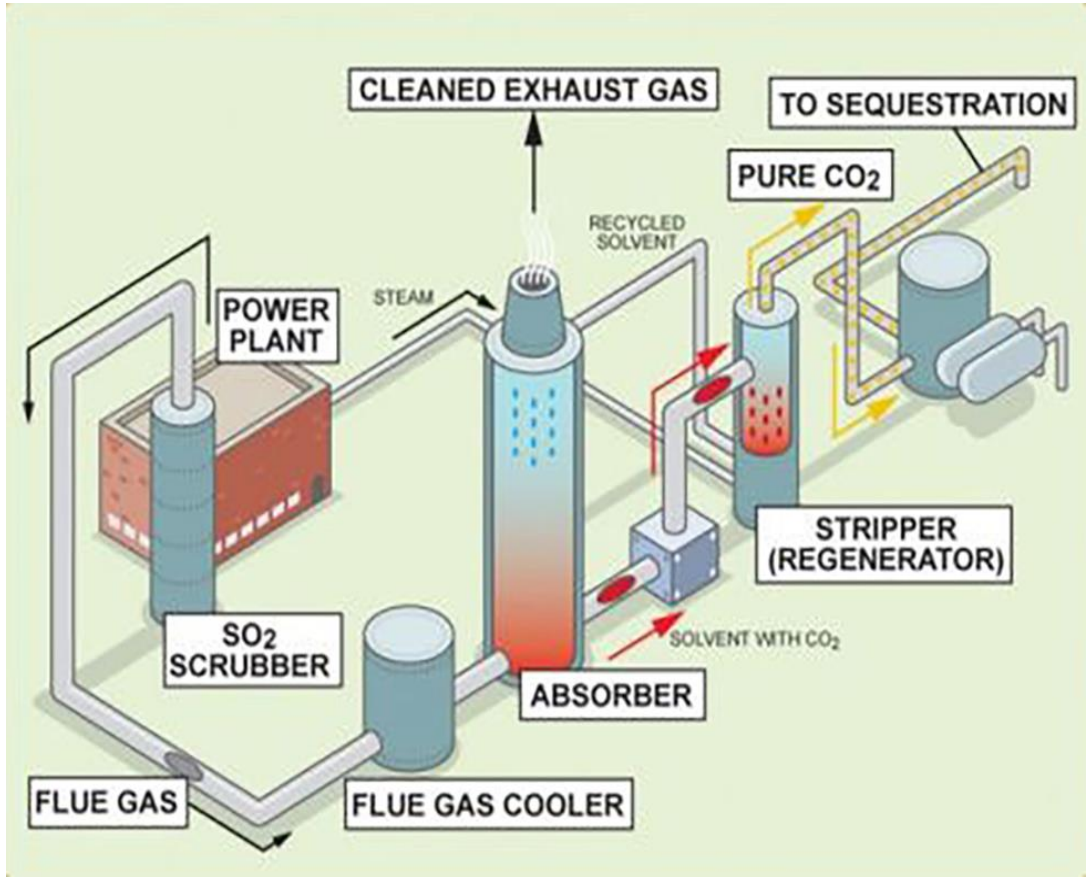
Carbon Capture & Storage



The full feasibility study, including evaluation of the impact and benefits of installing CCS technology, should commence before end 2021

- It is possible to reduce CO2 emissions by 90% from a natural gas power plant through the use of Carbon Capture and Storage (CCS) technology.
- CO_2 is captured from power station flue gases using special solvents which are then heated to release the CO_2, which can then be compressed and stored safely undergound, while the solvent is cooled and reused to capture further CO_2.
- CO_2 can be stored indefinitely in saline aquifers deep underground or injected into producing oil or gas fields to enhance the ultimate recovery of hydrocarbons from those fields.
- The technical and commercial aspects of applying CCS technology to the MSAP plant will be fully examined during the MSAP feasibility study, including discussions with local and regional stakeholders regarding the implications for electricity tariffs.

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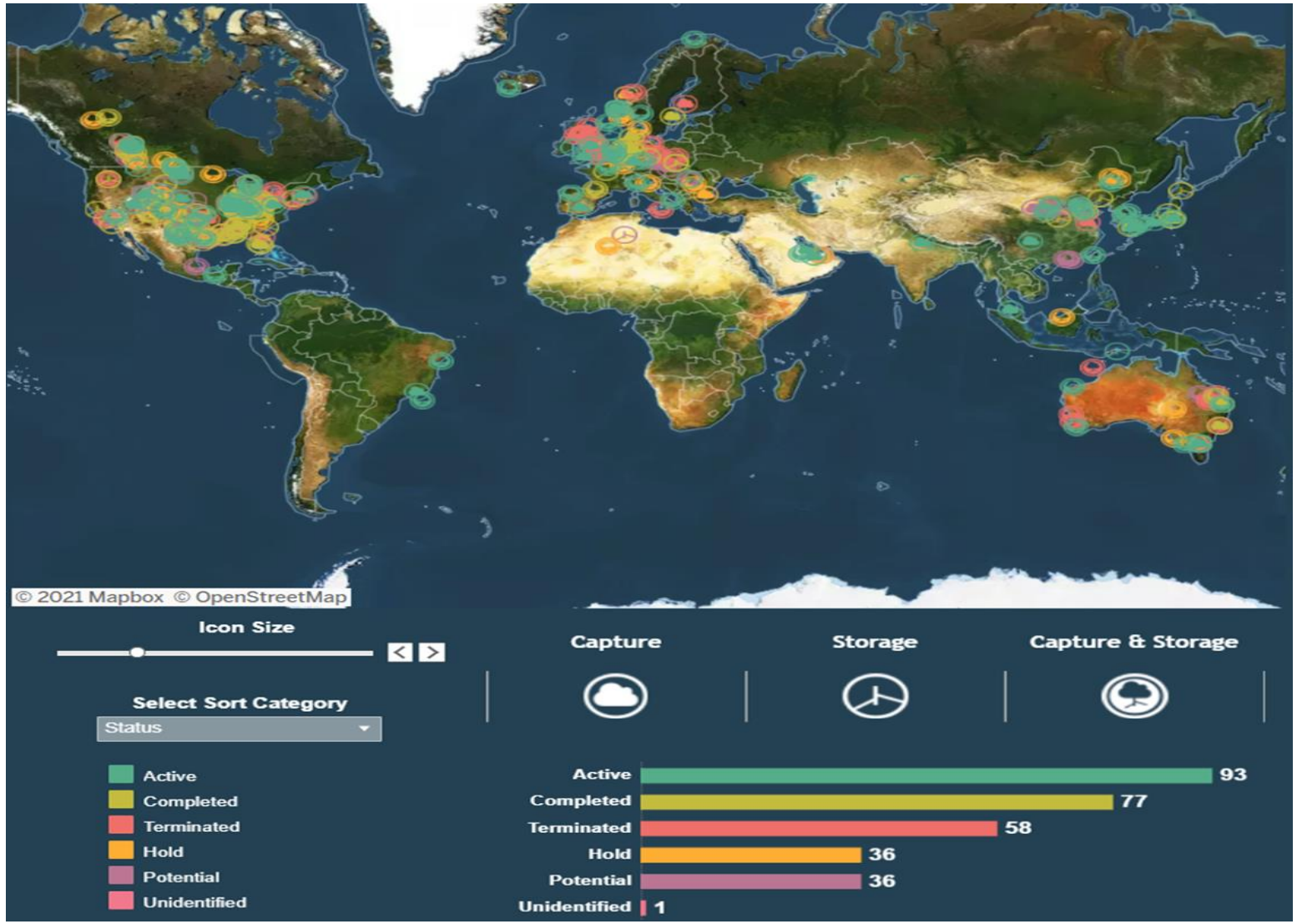
Carbon Capture & Storage



- There are no active CCS projects in Africa at present but several are ongoing in emissions conscious countries in North America, Europe, Asia and Australia.
- CCS with MSAP will be the first full Capture and Storage project in Africa

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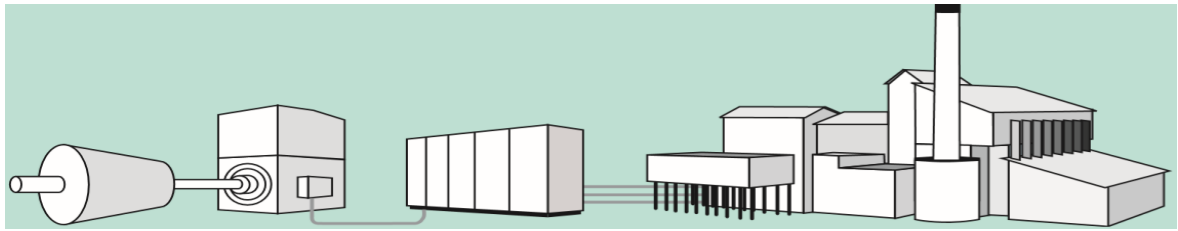
Electricity supply to LNG project

- Using electricity to power the 12.9MTPA Mozambique LNG facility will save maintenance costs, reduce fuel consumption and CO2 emissions, increase efficiency and save close to US$200 million a year.

Annual savings using an All Electric Drive system

Characteristics	A. Electric Drives	B. Gas Turbines	Difference
CAPEX system cost[1)]	Main drives $30 million Power plant $35 million Aux. drives $7 million	Main GT $25 million Power plant $14 million Aux. drives $7 million	$26 million
LNG production	6,250,000 tons/year	6,250,000 tons/year	
Maintenance costs	$5 million/year	$10 million/year	$5 million
Shaft power efficiency	36%	25%	
Fuel gas consumption	450 mmSCM	648 mmSCM	200 mmSCM
CO_2 emissions	800,000 tons	1,160,000 tons	360,000 tons
CO_2 quota cost where applicable (EU)	$13 million	$19 million	$6 million
Value of fuel gas	$100 million	$145 million	$45 million
Ten additional production days	$36 million	0	$36 million
Recirculation losses	0	$5 million	$5 million
Annual savings			**$91 – 97 million**



THE OPPORTUNITY



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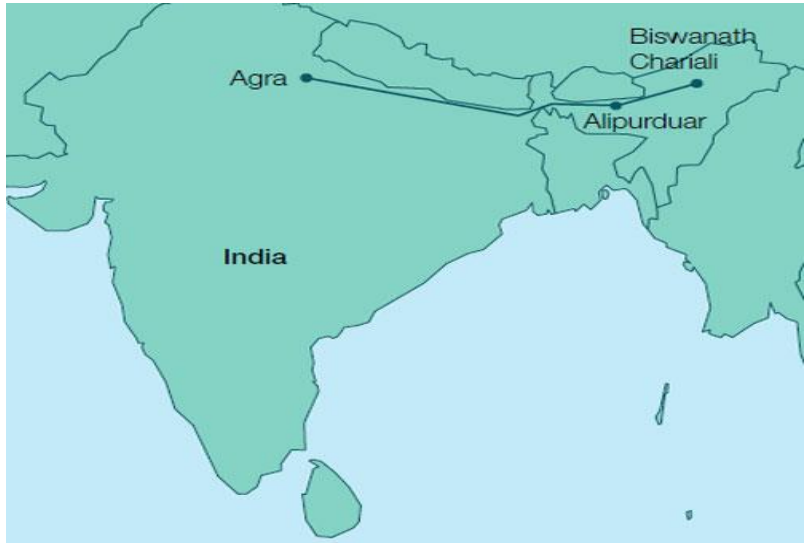
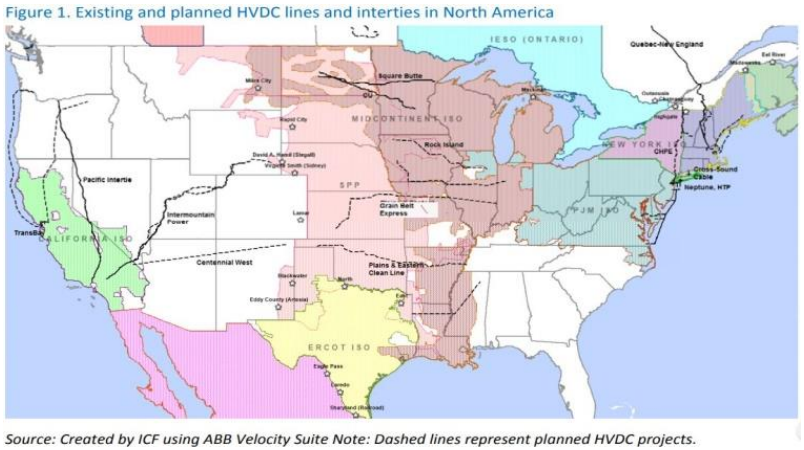
Feasibility

Examples worldwide show that comparable long and powerful transmission lines have been successfully completed.



1728 km NE Agra line has 8.0 GW capacity

2385 km Madiera line has 7.1 GW capacity



Multiple 1000+ km HVDC lines in the USA

1980 km Xiangjiaba –Shanghai line has 7.2 GW capacity

MSAP Plan 2022-2025:

- Construction of 2.3 GW CCGT Gas power station.
- Construction of 1090 km HVDC line with 2 GW capacity.
- Upgrade to Cahora Bassa line to 4GW.

Future Expansion 2025-2027:

- Construction of additional CCGT gas power station.
- Expansion of Mozambique HVDC line from 2-4 GW capacity.
- Expansion of Cahora Bassa line from 4-6 GW capacity or construction of 2 GW line to DRC.

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MSAP pre-feasibility study costs

Construction and operation of 2GW high efficiency CCGT plant

- Capital cost $1.5 - $2.0 Billion
- Electricity cost contribution ~$c1.8 - $2.3/kWh

Gas supply from LNG facility

- Gas price assumption $2.00-$3.00/mcf
- Electricity cost contribution ~$c1.35 to $c2.00/kWh

Construction of 500km AC lines at LNG facility and Songo for local power distribution in NE Mozambique and Malawi

- Capital cost $0.3 - $0.5 Billion
- Electricity cost contribution $c0.50 to $c1.00/kWh

Construction and operation of +/- 1090 km HDVC line from LNG facility to Songo, including right of way

- Capital cost $1.0 - $1.2 Billion
- Electricity cost contribution $c1.5 to $c2.0/kWh

Upgrades to existing Songo-Apollo HVDC line incl tariff

- Capital cost $0.25 - $0.5 Billion
- Electricity cost contribution $c0.50 to $c1.00/kWh

Total capital cost $3.1 - $4.2 billion

Electricity cost:

LNG Area $c4 to $c5/kWh

Songo $c5.5 to $c6.5/kWh

South Africa $c6 to $c7/kWh

Pre-feasibility study was conducted without CCS option. Adding post combustion proprietary solvent technology adds approximately 30% to capital costs in plant, with storage an additional 5-10%. Ways to recoup this will be studied in feasibility study and include:

- *Lower negotiated gas price*
- *Synergy with LNG project using CCS facilities and in CO2 storage*
- *Exemption from anticipated carbon tax*
- *CC(U)S adding value for carbon and CO2*
- *Green finance; project qualifying for low carbon project financing.*

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Broad spectrum of finance options

- Total recently signed a $14.9 billion debt financing agreement for their Mozambique LNG project, including development of the offshore fields and construction of the LNG facility onshore.
- Project financing includes loans from:
  - eight export credit agencies (ECAs)
  - 19 commercial banks
  - African Development Bank
- Export credit agencies include
  - Export Import Bank of the United States (EXIM)
  - Export Credit Insurance Corporation of South Africa
  - Japan Bank for International Cooperation
  - Nippon Export and Investment Insurance

- **US Government has designated LNG project as a priority**
- **Potential to develop operational, finance and security synergies between LNG and MSAP projects.**

- UK Export Finance (UKEF)
- Italy's SACE
- The Netherlands Atradius
- Export-Import Bank of Thailand

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TAPP-500 Project

Turkmenistan-Afghanistan-Pakistan High-Voltage Overhead Line Project

An example of similar project currently in progress with project manager and technology provider who are working on MSAP

- Project will follow “TAP Corridor” which could include TAPI gas pipeline, fiber optic cable line and high-speed rail line in future.
  1. Construction of high efficiency CCGT gas turbine with 1.574 GW capacity ***(completed).***
  2. A 375 km AC line with 300 MW capacity from Mary to Herat and
  3. A 575km AC line from Herat to Kandahar ***(due to complete August 2021).***
  4. A 1,150 km HVDC line with 1.2 GW capacity from Mary to Quetta.
  5. Construction of second CCGT plant, increase capacity to 4 GW, extension of HVDC line 520 km to Multan and Pakistan power grid.
- Construction of points 2-4 are taking three years at an estimated cost of US$2 billion.
- Project is being built and operated by private enterprise.
- Gas supplied from Galkynysh Field (2.8 TCM) in Turkmenistan
- The project will expand in next phase and connect to Pakistan national electricity grid from Quetta to Multan.

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Next Steps

- Feasibility Study
- Intergovernmental agreement (Mozambique, Malawi and South Africa)
- Initiate discussions with Zambia and DRC and cobalt and copper producers on NW spur from Songo connector
- Negotiations with gas suppliers
- Land and Infrastructure agreements
- Electricity purchase agreements
- Financing plans

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