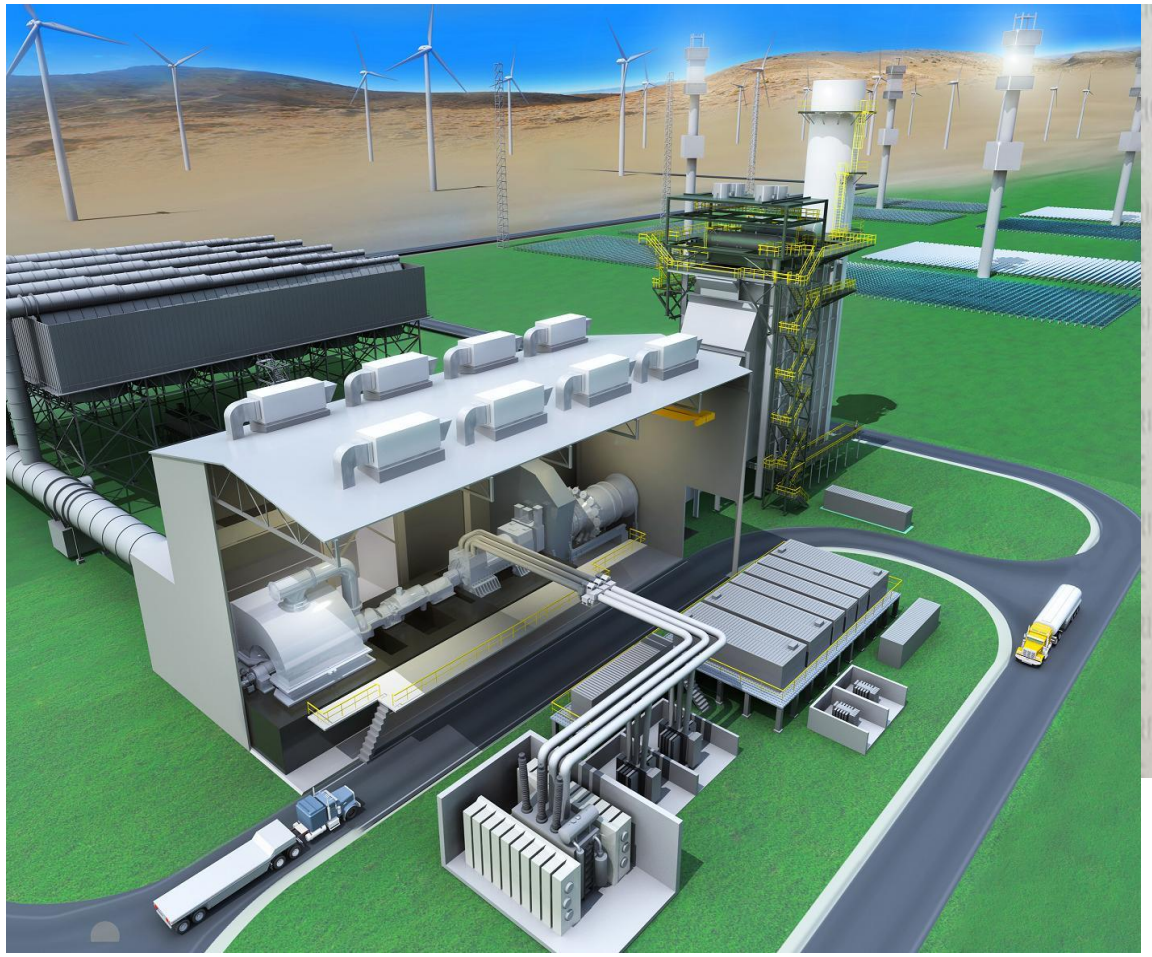
The MSAP Project

Mozambique-South Africa Power Generation, Transmission and Carbon Capture project



REPÚBLICA DE MOÇAMBIQUE
MINISTÉRIO DOS RECURSOS MINERAIS E ENERGIA
GABINETE DO MINISTRO

DESPACHO Nº 23/2022

Com vista ao desenvolvimento de um projecto de geração, distribuição local, transmissão para exportação de energia eléctrica e captura de carbono, a empresa **Mozambique Southern Africa Power (MSAP)**, um consórcio constituído pelas empresas Anglo Eurasia Power Africa LLC,

Authorization by Mozambique Ministry of Energy for MSAP to proceed with full feasibility study 11/22

MSAP Concept

Project Overview

1. Generate power with low-cost gas from Rovuma LNG project area to electrify LNG facilities, promote economic growth in Cabo Delgado and alleviate significant power shortages in South Africa and across the Southern African Power Pool (SAPP).
2. Minimize CO2 emissions for the MSAP project and thus the LNG facilities by incorporating CC(U)S technology in the power plant.
3. Transmit clean power through new build HVDC line to Songo to connect to the regional SAPP grid and the existing Cahora Bassa HVDC infrastructure to South Africa, with sales to South Africa state owned transmission company on long term PPA.
4. Additional sales of power to other projects in LNG area, northern Mozambique and Malawi customers.
5. Connect to SAPP regional grid to facilitate additional sale of power to multinationals in DRC and Zambia engaged in mining and refining of rare earth and critical minerals and to the Electricity Trading System.

Advantages

- Two of the major capital components, gas production and the Songo Apollo HVDC line, are **already built**, requiring only minor additional expenditures.
- **Several major sources** of power sales - LNG plants, South Africa and multinational mining companies - reduces risk
- Cooperation with TotalEnergies and ExxonMobil led LNG project **reduces costs of CCS**

Image: Total Energies

Power Generation and Transmission

Power Generation

- 3GW high efficiency CCGT plant, to be constructed adjacent to the LNG facilities in Rovuma.

- Gas for the power plant will be sourced from TotalEnergies and/or ExxonMobil onshore facilities through low-cost incremental development of offshore fields under a long-term purchase agreement.

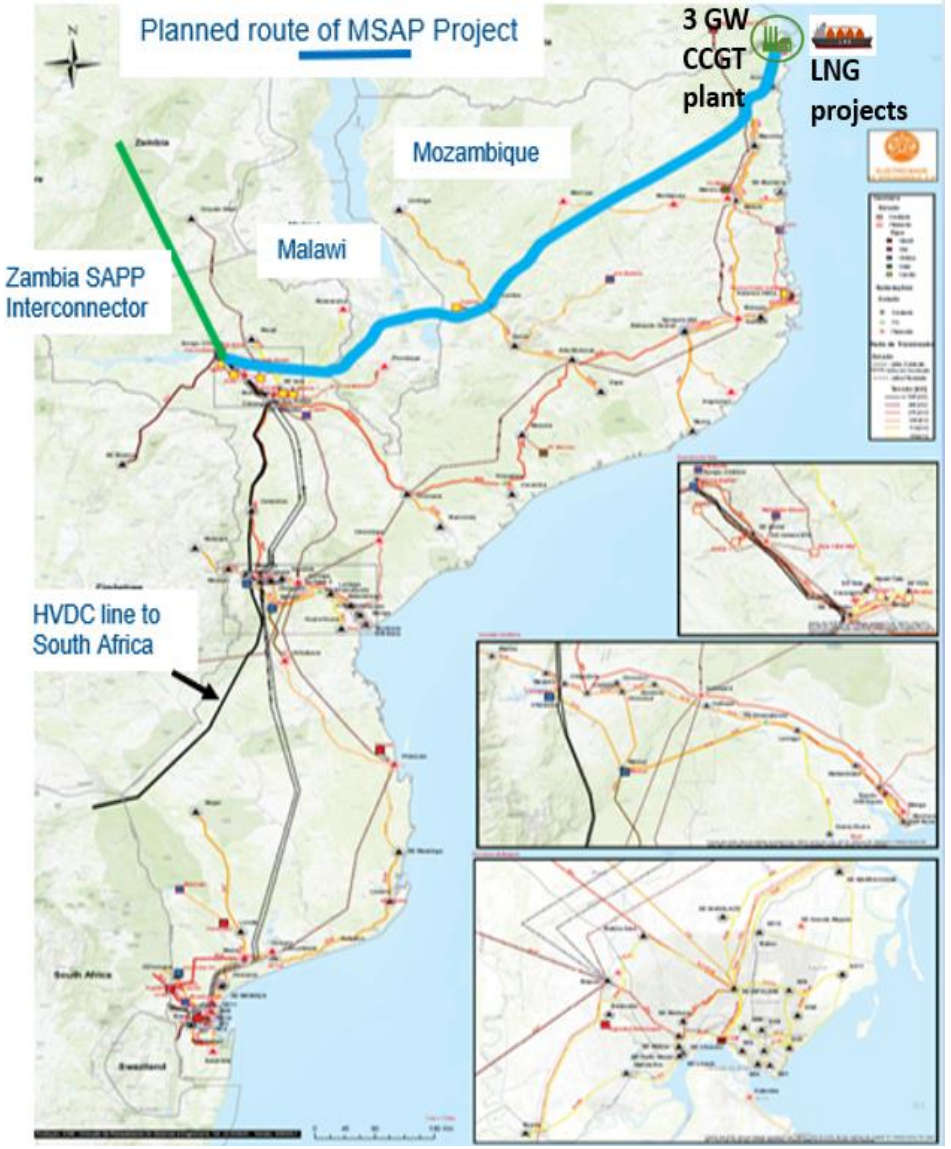
- If ExxonMobil Area 4 onshore facility not developed, augment ENI FLNG development to bring gas to shore to meet domestic supply obligation.

Power Transmission

- A 1090 km 2GW HVDC power line to be constructed from the power plant to the Songo HVDC station; the power line will follow the Nacala Logistics Corridor through Malawi.

- HVDC rectifier at Songo to be upgraded to increase existing line capacity to SA to 3960MW – Apollo inverter already upgraded.

- Songo is a regional hub and entry point for the SAPP grid, facilitating sale of excess electricity through the short-term electricity trading system.



Carbon Capture, Utilization and Storage

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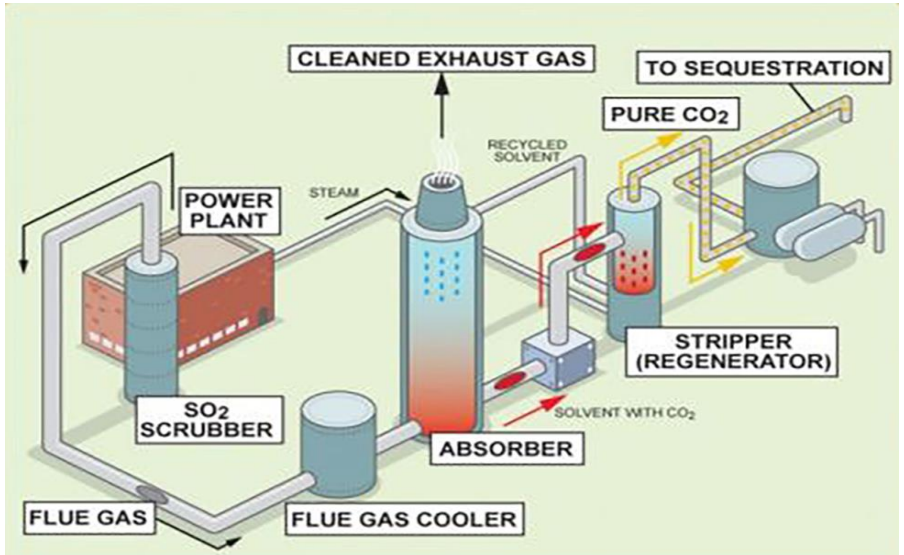
CO_2 Capture and Storage

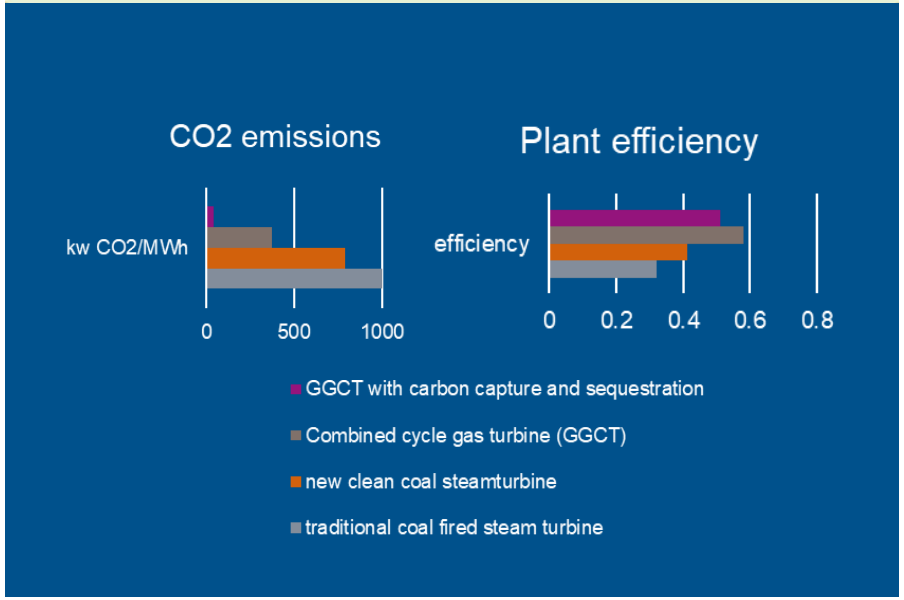
- Utilize latest CCUS technology to virtually eliminate CO_2 emissions from the power plant.

- 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 underground, while the solvent is cooled and reused to capture further CO_2:

  - Further development of CCUS technology - and cost reduction – is seen to be the key to achieving Carbon Neutrality in the next few decades.

  - Very few commercial CCUS operations globally at present, Mitsubishi Heavy Industries (MHI) and ExxonMobil are leading technology providers and Anglo Eurasia is engaging with them.





Mozambique Integrated Master Plan 2018

Mozambique Integrated Master Plan envisages thermal power generation

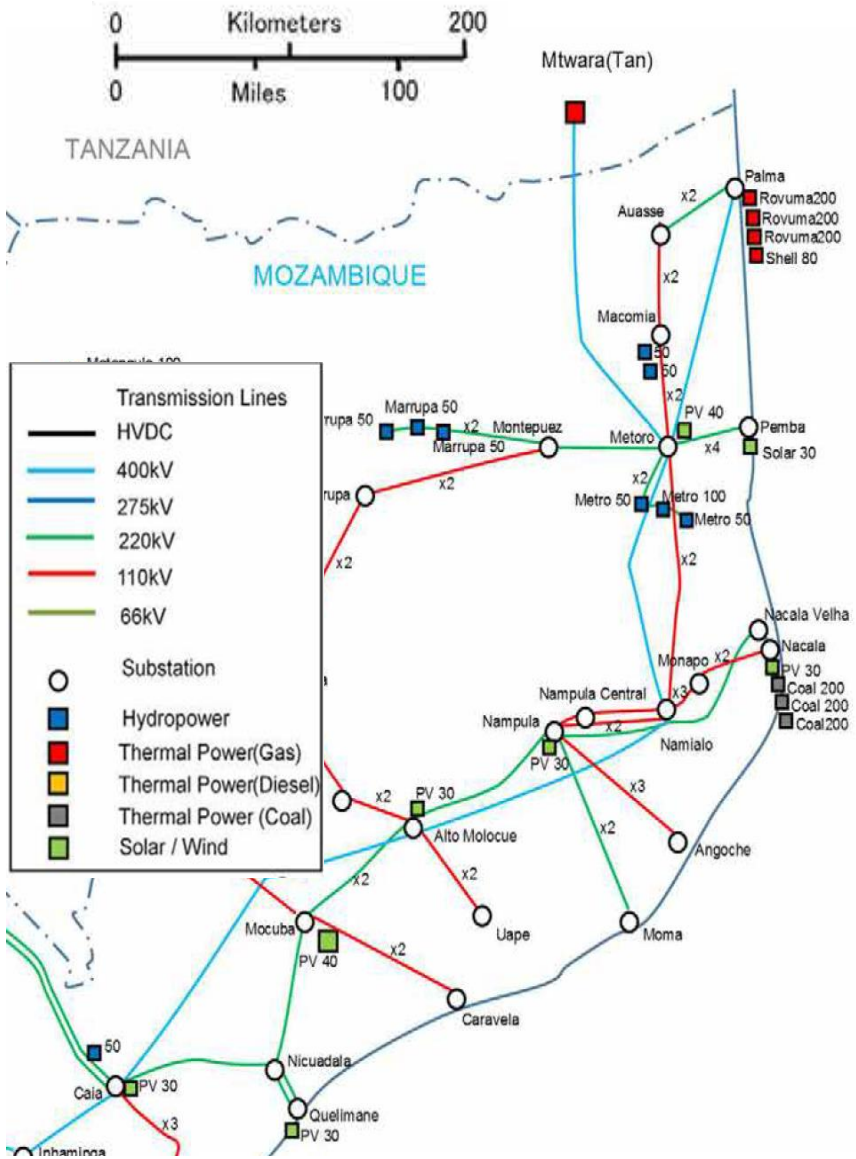
- Mozambique's Integrated Master Plan (IMP) 2018 proposes the addition of 1480MW of thermal power generation capacity in north-east Mozambique by 2042:
  - Rovuma 4 x 200MW + 1 x 80MW, all CCGT
  - Nacala 3 x 200MW Coal

Advantages for large scale power station

- Building one large CCGT station to cater for the total current and future demand has several advantages:
  - Higher efficiency power plant (large CCGT 60%)
  - Significant economies of scale during construction
  - Environmental approval for coal power stations more difficult to achieve despite significant investments in emissions controls for SO_2 and NO_x
  - Finance for coal projects becoming more difficult due to global warming concerns – world switching to gas and renewables

- Construction of HVDC line from Rovuma to Songo brings bulk power to Tete, reducing requirement for planned 1200MW coal plant, and facilitates export of excess electricity to South Africa

- Additional generation units can easily be added to the CCGT station as demand grows given the enormous gas resource



Business prospects and profitability

Severe power supply shortage in SA through 2050

- 2020 Load shedding - unserved demand - 1798 GWh.
- Decommissioning 20 GW of the existing coal power generation capacity.
- Uncertain hydro capacity – reservoirs being depleted, an impact of climate change.
- Considerable expansion of wind and solar planned, but the need for reliable base load remains.

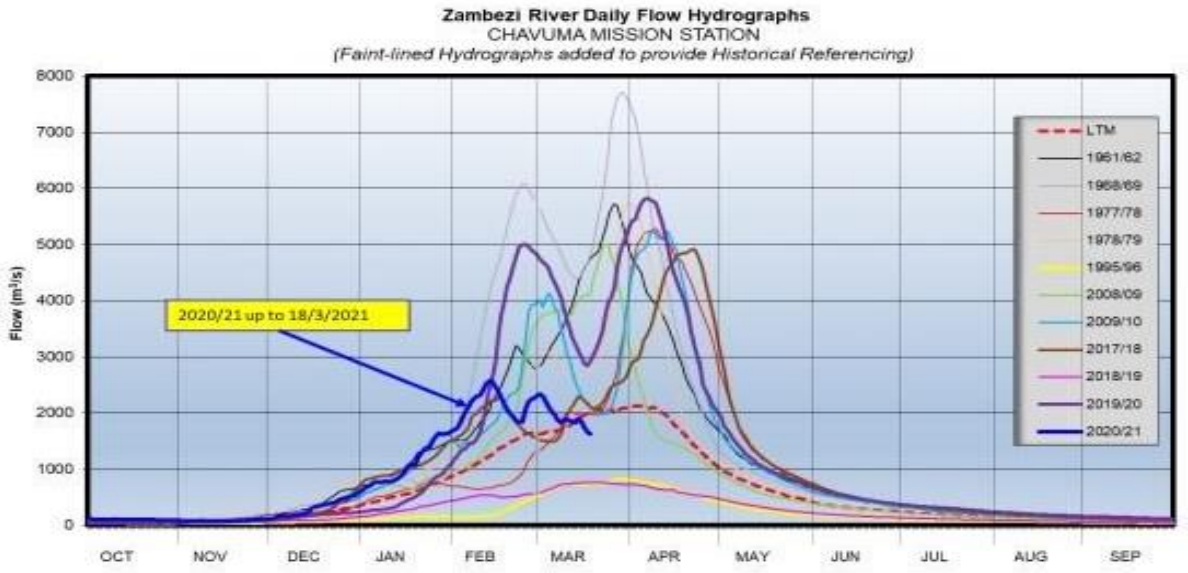
Est. cost of MSAP power delivered in South Africa

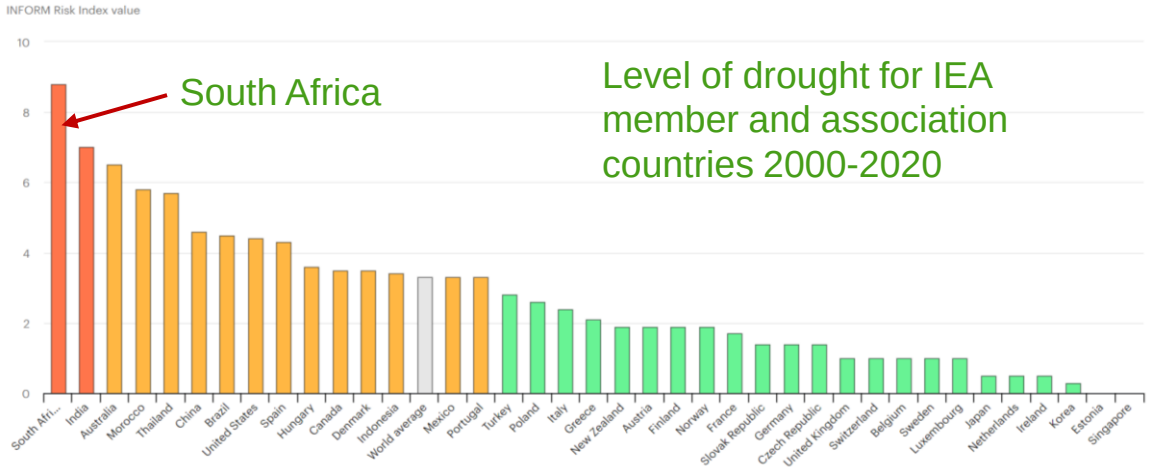
- US$0.08 -0.09/kWh plus CCS costs.
- Current marginal power generation cost in SA ~ US$0.10.

Further potential – electricity trading on SAPP platform

- System facilitates trade of excess power across the region to countries with deficit.
- Up to 250MW traded despite lack of excess in SAPP member countries.
- 80% of power traded on Day Ahead Market (DAM)
- Pricing from $.03 to $.05/kWh off peak to $.12 to $.16/kWh in peak period.
- Trading system is on pre-paid basis and has dual currencies – Rands and $US – banked in Botswana.

Climate change is severely affecting southern Africa putting hydro power viability in doubt





Electricity supply to LNG project

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All Electric LNG Plants

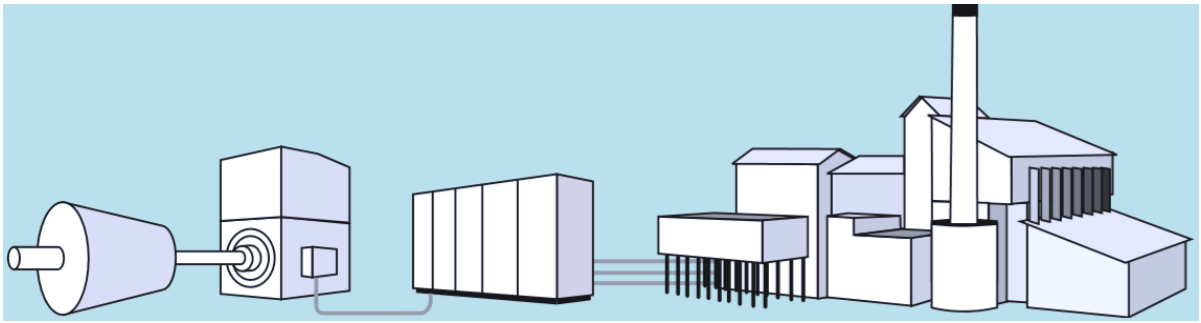
- Using electricity to power the 12.9 MTPA Mozambique LNG facility will save maintenance costs, reduce fuel consumption and CO2 emissions, increase efficiency and save close to US$200 million a year.

- Greater savings if the larger ExxonMobil facility is electrified.

ABB

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**



MSAP complements Hydro projects in Mozambique

- There are three greenfield hydro projects along the Zambezi totaling 2,320 MW in capacity:
  - Mphanda Nkuwa – 1,500 MW
  - Boroma – 210 MW
  - Lupata – 610 MW

- The Government of Mozambique plans to build a north-south “back-bone” connection to supply power internally throughout the country, taking a share of this power supply (*see figure on the right*).

- Even without drought-driven capacity reduction, these hydro projects alone cannot satisfy the medium to long term demand in neighbouring countries.

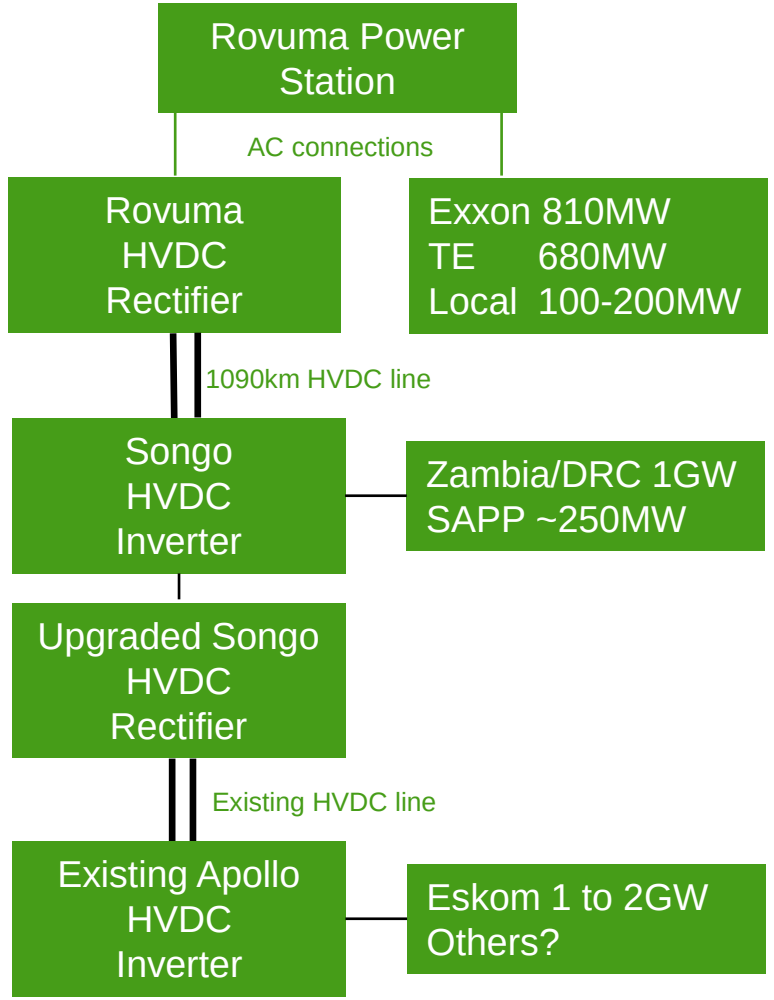
- Given this aggregate excess power generation capacity in Mozambique vis-à-vis the regional power deficit, electricity should flow west-ward.

Building blocks – significant regional demand

BLOCK 1 – Sufficient power to supply LNG facilities with efficient low emissions power and meet initial limited local demand.

BLOCK 2 – HVDC connection to Songo in Mozambique brings power to Southern African Power Pool trading system and planned interconnector to Zambia with extension to DRC.

BLOCK 3 – Significant unsatisfied demand in South Africa. Existing HVDC line can handle additional 2GW. Songo Rectifier to be upgraded, Apollo Inverter requires modifications if addition more than >1GW.



MSAP pre-feasibility study assumptions

Total Capital Cost: $5 - $6.5 billion

- Construction and operation of 2GW high efficiency CCGT plant
  - Capital cost $2.4 Billion

- Gas supply from LNG facility
  - Gas price to be negotiated

- Construction of 500km AC lines at LNG facility and Songo for local power distribution in NE Mozambique and Malawi
  - Capital cost $0.2 Billion

- Construction and operation of +/- 1090 km HDVC line from LNG facility to Songo, including right of way
  - Capital cost $1.9 Billion

- Upgrades to existing Songo-Apollo HVDC line
  - Capital cost $0.5 Billion

Electricity Cost

- LNG Area $c4.5 to $c5/kWh
- Songo $c7.5 to $c8/kWh
- South Africa $c8.2 to $c8.7/kWh

CCS Option

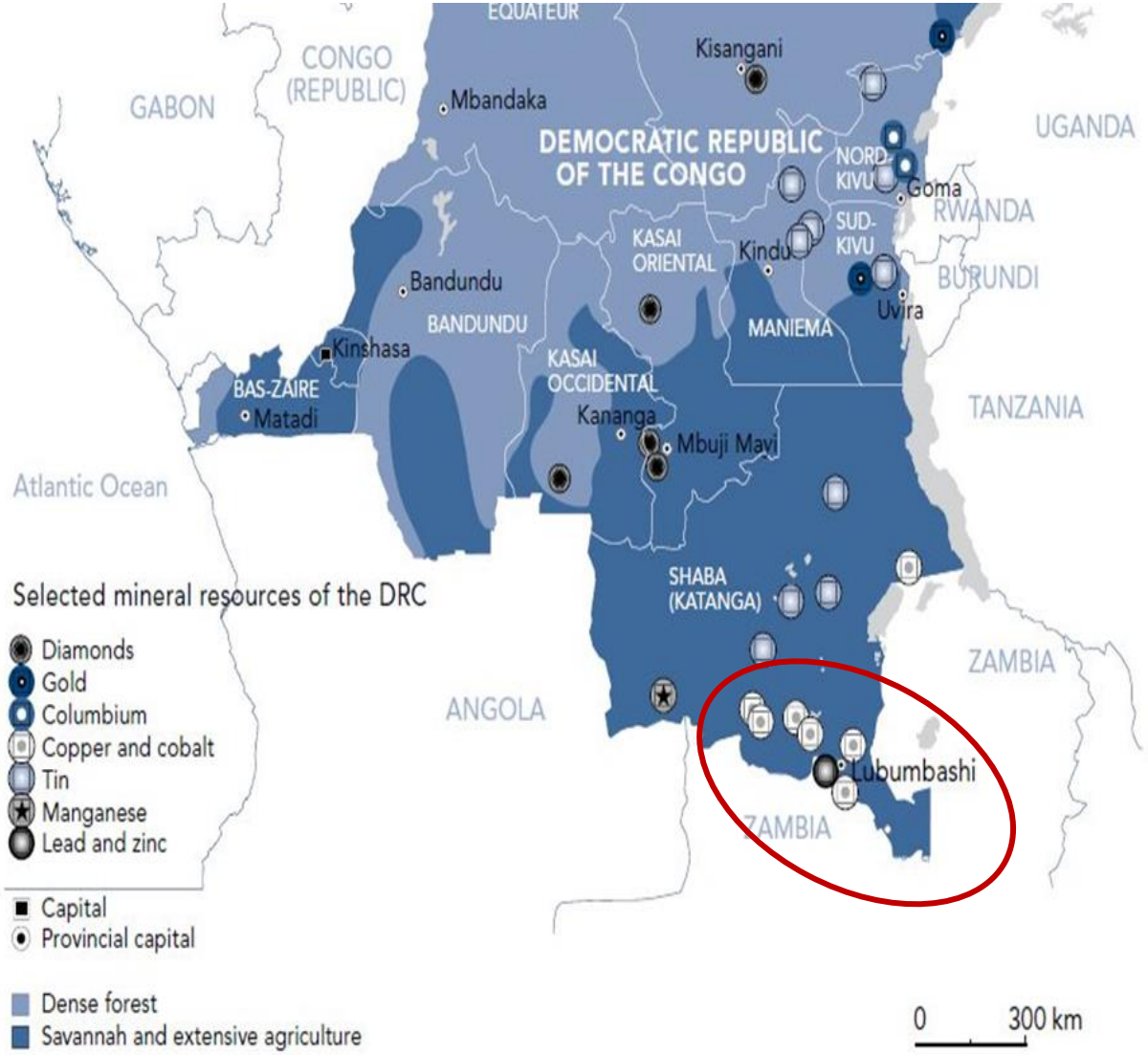
- The pre-feasibility study was conducted without the CCS costs as these are under review

- Adding post combustion proprietary solvent technology adds approximately 30% to capital costs of the 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.

DRC – unserved power demand and badly needed minerals for renewables

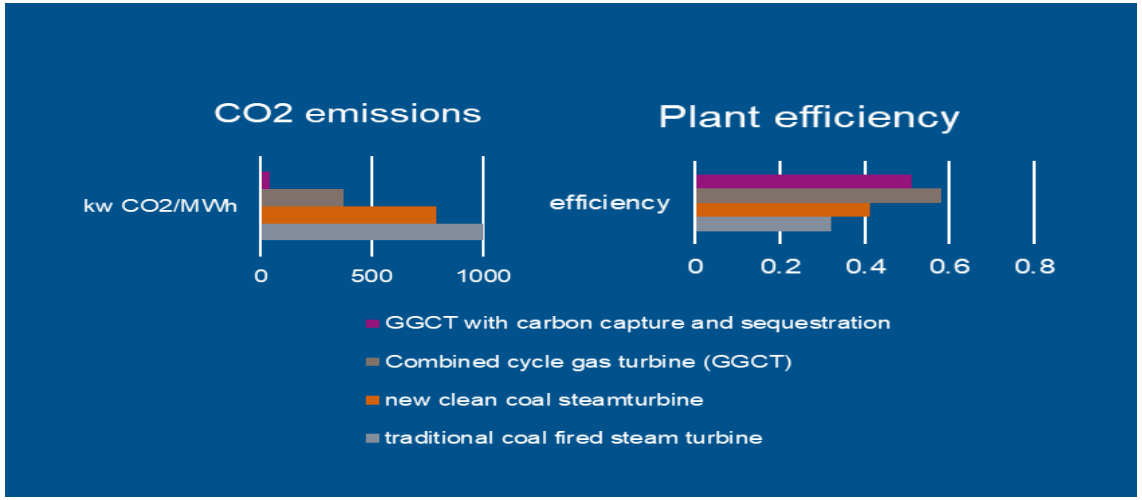
- The IEA's Sustainable Development Scenario sees strong growth in demand for minerals used in renewables, storage and electrification of transport.
- The copper belt of the DRC holds significant resources of many of these minerals but lack of power is a significant impediment to growth of mining operations 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.
- MSAPP could utilise this interconnector to bring initial MSAPP power to Zambia and on to Katanga in the DRC.
- Future supply of 2 to 4GW could be accommodated through extension of the MSAPP HVDC infrastructure directly from Songo in Mozambique.



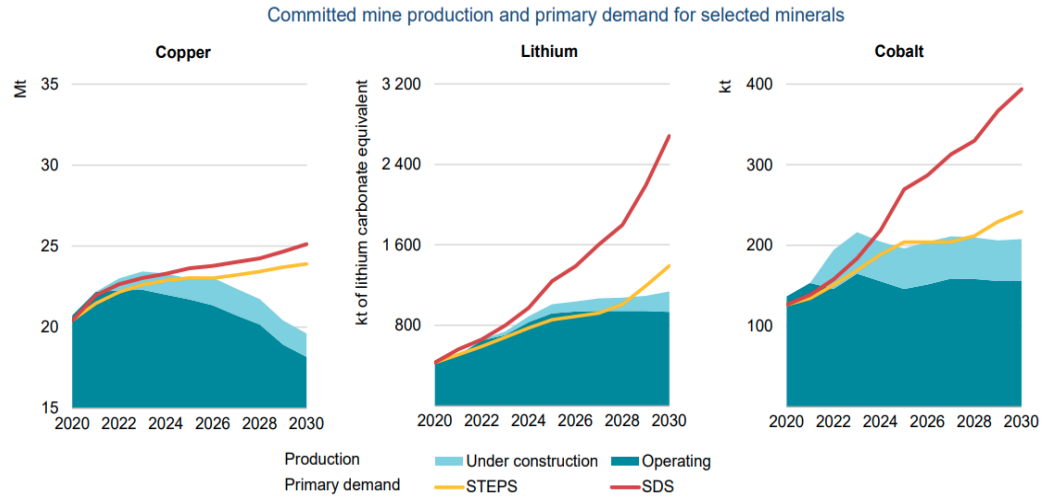
Contribution to the global drive to curb CO2 emissions

- With CCUS, virtually zero CO2 emission from the power plant and zero emissions from E-LNG plant.
- Replacing coal power plants in SA.
- NW spur to Zambia and DRC: supply of power to mine and process critical metals required for renewable energy

- Lead time of 10-15 years needed from investment decision to production for major minerals projects.
- By 2030 world will be critically short of key minerals needed for renewable based power and transportation



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



Next Steps

- Full Feasibility Study
  - Funding requirement US$ 6 million
- Intergovernmental agreements (Mozambique, Malawi and South Africa)
- Engage with Southern African Power Pool (SAPP)
- Establish strong consortium
  - MSAP (AEPA, LINDEN ENERGY)
  - TOTAL
  - MITSUBISHI HEAVY INDUSTRIES (MHI)
  - ExxonMobil
  - Further strategic investor(s)
- 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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