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The Orange Basin, Deepwater Namibia – One of the World's Newest and Hottest Oil and Gas Hunting Grounds

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Beginning in early 2022, reports were coming from Namibia that major oil discoveries have been drilled in the deepwater area of Namibia's Orange Basin. This presentation will review the status of this ongoing exploration program and speculate as to where it is all going.

Since the 1960s Namibia was viewed as a graveyard for oil and gas explorers. Many companies tested Namibia's coastline at various times including Chevron, Shell, Exxon, Texaco, Petrobras, Norsk Hydro, Equinor, Total, Tullow Oil, HRT Oil & Gas and others. Except for the modest-size, never-produced Kudu gas field, discovered in 1974, nothing but dry holes. But in the past two years, perhaps more than 10 billion barrels of oil and gas equivalent resources have been discovered. Sixty years after those early years of exploration, Namibia's luck may be turning around.

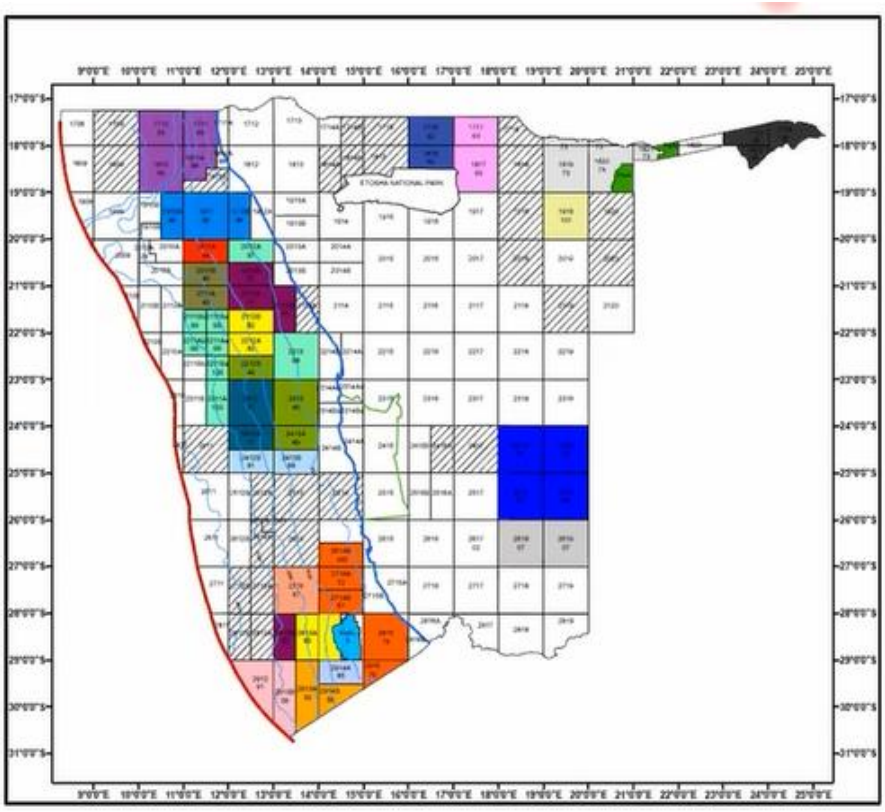

Figure 1. Namibia's Oil and Gas Concessions. From: NAMCOR, 2022

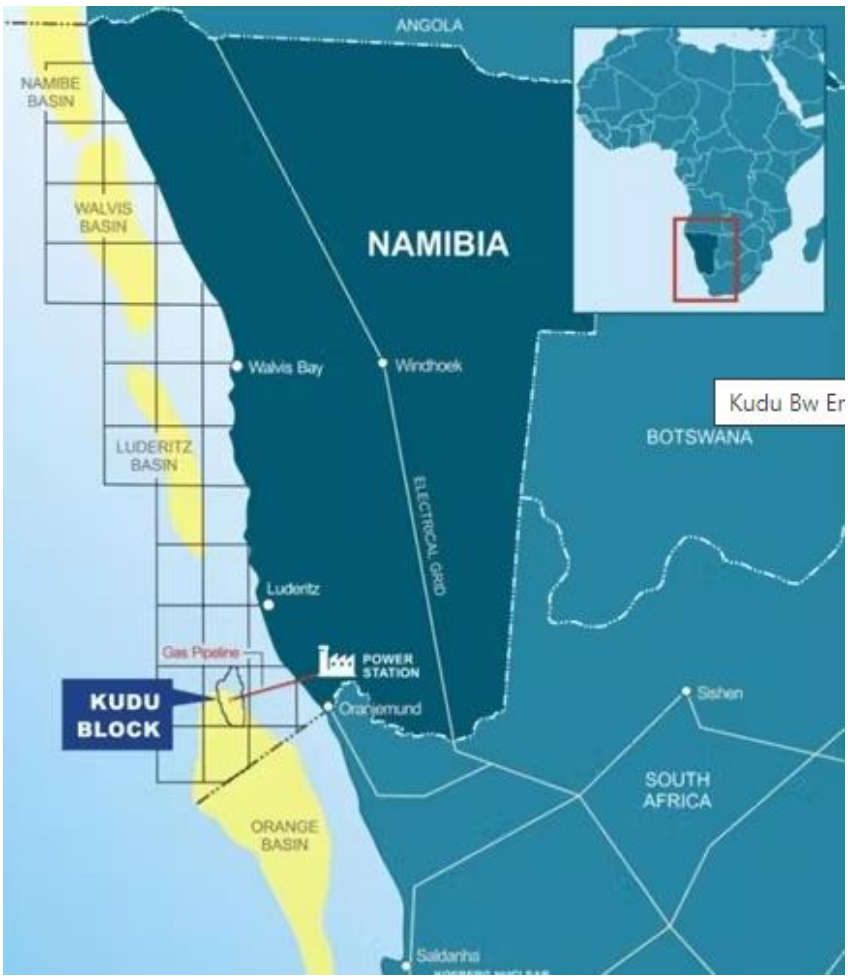

Figure 2. Locations of Namibia's offshore sedimentary basins. Also shows the location of the Kudu gas field.
From: Offshore magazine, October 26, 2021.

Graff Oil Discovery, Orange Basin

In January of 2022, rumors began that Shell had made a mega-oil discovery in the Graff-1 exploration well in the deepwater of Namibia's Orange Basin. Shell is operator with a 45% working interest and partners include Qatar Energy with 45% and NAMCOR, the national oil company of Namibia with 10%. Graff-1 was drilled in 1,962 meters (6,435 feet) of water to a depth of 5,376 meters (17,633 feet). The well is located 270 kilometers (162 miles) from the coastline. Shell confirmed the news on February 7, 2022, and oil industry analytical companies such as Wood Mackenzie estimated that the Graff field has recoverable resources of 700 million barrels of light oil. The reservoirs are Upper Cretaceous (Cenomanian) marine sandstones.

Shell subsequently drilled the La Rona appraisal well which was aggressively positioned as a long-distance step-out well 8 kilometers (5 miles) northeast of the discovery. Namibian government officials in a virtual presentation in April 2022 to the Canadian Global Exploration Forum (CGEF) in Calgary indicated that La Rona was “looking very good”. According to the ongoing rumor mill, the results of La Rona were so positive it raised expectations that Graff could contain 1 billion barrels of oil recoverable and up to 6 trillion cubic feet of gas. Accordingly, on a 6 mcf gas to 1 barrel-oil-equivalency, Graaf may have recoverable resources of 2 billion barrels of oil and gas.

This past December, Shell spudded the Jonker-1 exploration well about 18 kilometers (11 miles) west of Graff. This will be a three-well program which includes a production test on the Graaf-1 discovery well and a second exploration well, Lesedi-1. The Jonker-1 well is reported to be exploring for a different geological play from the Upper Cretaceous light oil discoveries made in Shell’s Graaf-1 and La Rona-1 exploration wells. Instead, Jongker-1 is targeting an eastern extension of the Lower Cretaceous oil and gas play that TotalEnergies found in its Venus-1X exploration well (Upstream January 24, 2023). Jongker-1 is rumored to have intersected hydrocarbons is a shallow reservoir, offering significant encouragement to what may yet be found in the well’s deeper primary objective. The well is rumored to be undergoing testing as of February 7, 2023. For oil industry observers and analysts, the magnitude of the play-opening Graaf discovery is truly amazing. Unconfirmed rumors now indicate that Shell is already giving thought to utilizing at least one floating LNG vessel to produce the gas and an FPSO to produce the oil.

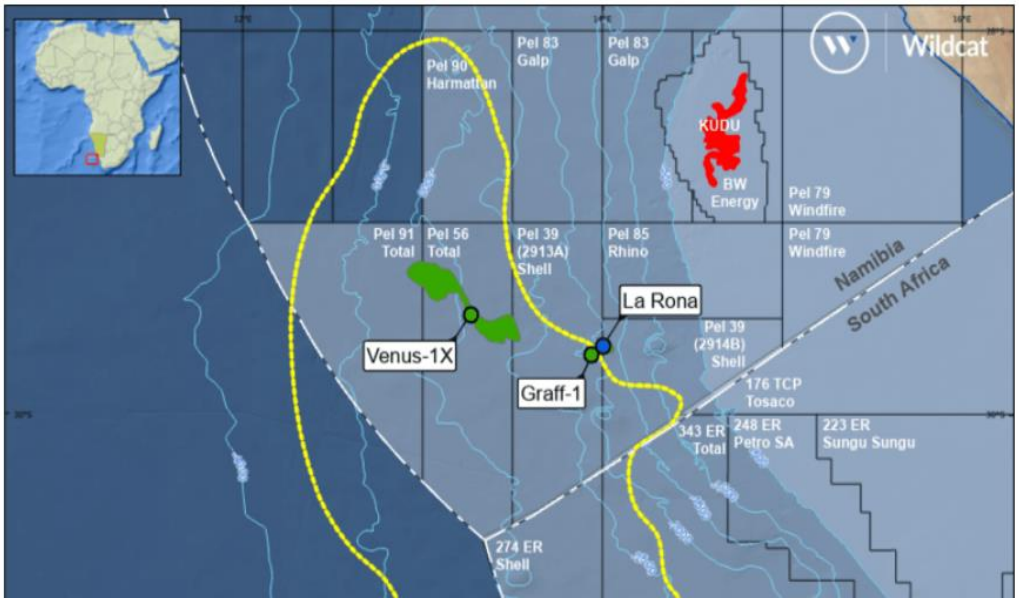

Figure 3. Locations of Graff and Venus oil discoveries, La Rona step-out well and Kudu. Yellow outline is the extent of the Cretaceous Aptian-Albian oil play. From: OilNOW, Westwood, April 9, 2022.

Venus Oil and Gas Discovery, Orange Basin

Two weeks after Shell's announcement about Graff-1, TotalEnergies announced on February 24, 2022 that the Venus-1X deepwater exploration well drilled in Block 2913B had intersected 84 meters (275 feet) of net pay in a high-quality Lower Cretaceous sandstone reservoir containing light oil and associated gas. Informal reports mentioned that in fact the well intersected as much as 250 meters (820 feet) of net pay (Upstream, November 25, 2022). The well was drilled in 2,900 meters (9,515 feet) of water to a total depth of 6,296 meters (20,657 feet) and is located 290 kilometers (174 miles) away from the coast. The reservoir is rumored to cover about 600 square kilometers.

Soon after Venus-1X was completed, Wood MacKenzie was reported in various oil industry publications that Venus may have recoverable oil resources of about 3 billion barrels of oil which positions Venus as Sub-Sahara Africa's largest ever oil discovery. If these estimates are confirmed by drilling, then Venus is larger than Nigeria's giant Agbami, Akpo and Engina fields and Angola's giant Girassol and Dalia oil fields. The latest informal reserve estimates are now 12 billion barrels of oil and 20 trillion cubic feet of gas (Upstream, November 25, 2022). TotalEnergies is operator of Venus-1X with a 40% working interest and the partners include Qatar Energy 30%, UK-based Impact Oil & Gas 20% and NAMCOR with 10%. Vancouver-based Africa Oil Corp has a stake in Venus through a 31% working interest in Impact Oil & Gas. Keith Hill, chief executive officer of Africa Oil Corp said that the operator, TotalEnergies, would fast-track Venus' development through an early production system. Hill stated QUOTE "I think it will go very fast when we have at least two wells that are tested and confirm the lateral continuity and deliverability of the reservoirs. I think you'll see this project moving very quickly into an early production phase" UNQUOTE. (Upstream, November 25, 2022).

Very recently, Chevron who have acreage also along the Venus trend has indicated that it is refining and accelerating seismic surveying and drilling plans (Upstream, December 9, 2022).

In view of the possible large extent of the Venus discovery, the field may eventually be produced through several FPSOs. To the great surprise of long-time observers - including myself - of Namibia's oil and gas activity, in the next decade Namibia could become Sub-Sahara's third largest oil producer after Nigeria and Angola. The combination of the Graff and Venus discoveries amounts to almost unimaginable resources of oil and gas. This oil and gas play also extends southwards into South Africa where one or more exploration wells will be drilled this year.

As of the time of the completion of this abstract on February 15, 2023, there is little data available on the drilling in the deepwater Orange Basin since the wells drilled by Shell and TotalEnergies are still super-confidential. However, any information which becomes available through press releases or announcements by the operators or partners in the wells - such information will be included in my presentation at GeoConvention.

Impact Oil & Gas' Assessment of the Deepwater Orange Basin

The following is directly taken from Impact Oil & Gas's website, February 14, 2023. QUOTE "The oil and gas found in Venus-1X occurs in a world class Albian-age basin floor fan deposit. In the Orange Basin a world class source rock known as the "Kudu Shale" has kept the light of intrigue alive for the committed explorers. Impact Oil & Gas postulated that the focus of exploration required a shift from the shelf and slope to the ultra-deepwater plays further off to the west, directly ahead of the Orange River systems of southern Africa as shown in Figure 4.

High fidelity 2D and 3D seismic revealed an extensive basin floor fan deposit of Albian age directly overlying the Kudu Shale source rock (Figure 5). The fan is known as the "Venus Fan", that had subsequently placed into a favorable, counter regional trapping configuration. The trap was formed due to the differential loading of overlying mass-transport deposits and this process pre-dates the onset of source rock oil maturation.

The presence of a viable hydrocarbon filled trap was further de-risked by extensive depth conforming seismic anomalies over the northern part of the Venus Fan (Figure 5). The light, sweet oil found at Venus, resides within high quality, thick, blocky turbiditic sands. Initial analyses from the Venus-1X well suggest that the discovery has confirmed, or in most cases, exceeded pre-drill metrics.

The discovery of Shell's Graff Field within the neighbouring 2913A block, proves the potential for further exploration upside within the Upper Cretaceous interval above the Venus discovery (Figure 6)". UNQUOTE.

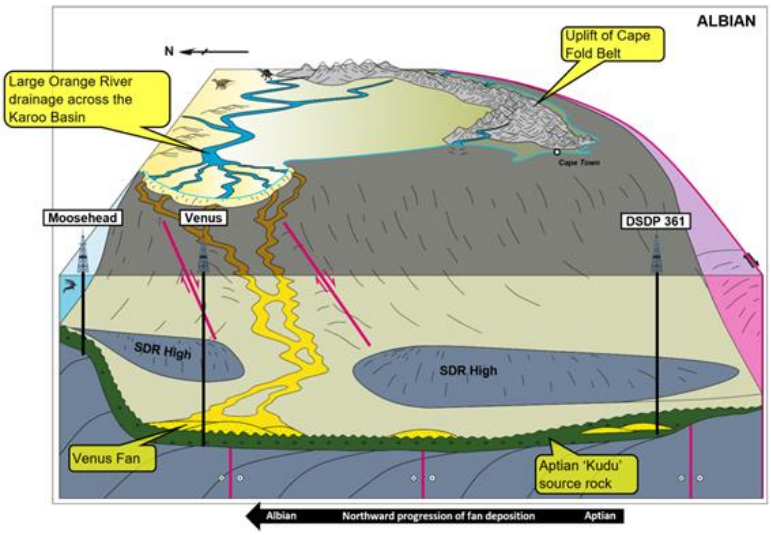

Figure 4. Deposition of the Albian-aged Venus Fan in the outer Orange Basin directly on to the Aptian aged "Kudu Shale" source rock. From: Impact Oil & Gas website, February 14, 2023.

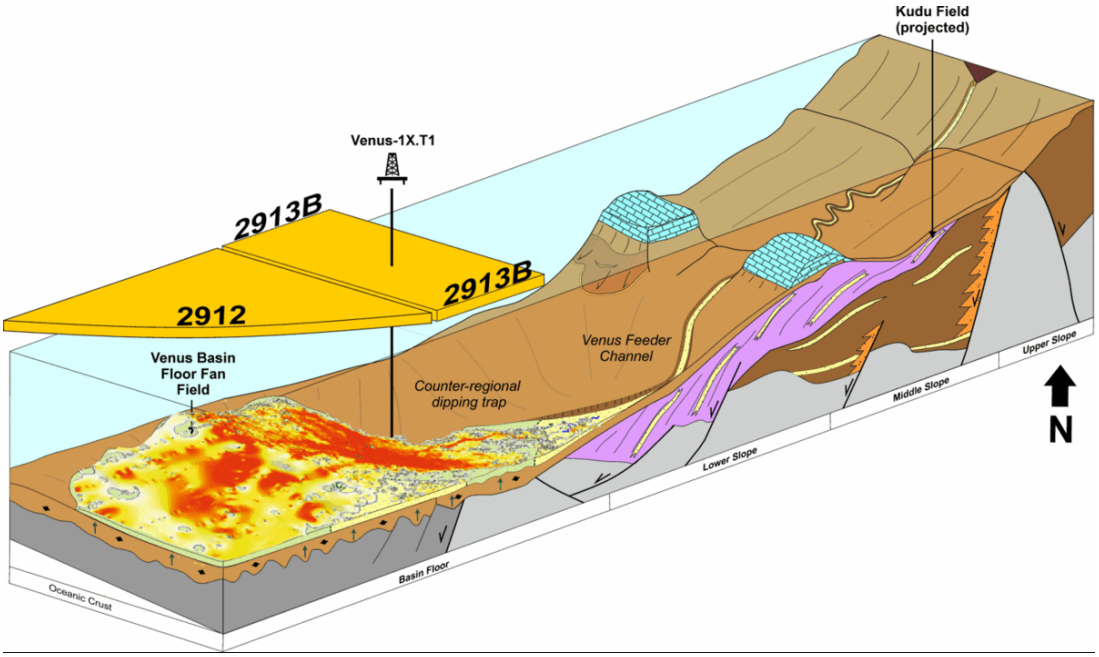

Figure 5. Favorable trapping of the northern Venus Fan is supported by depth confirming amplitude anomalies from the 3D seismic. From: Impact Oil & Gas website, February 14, 2023.

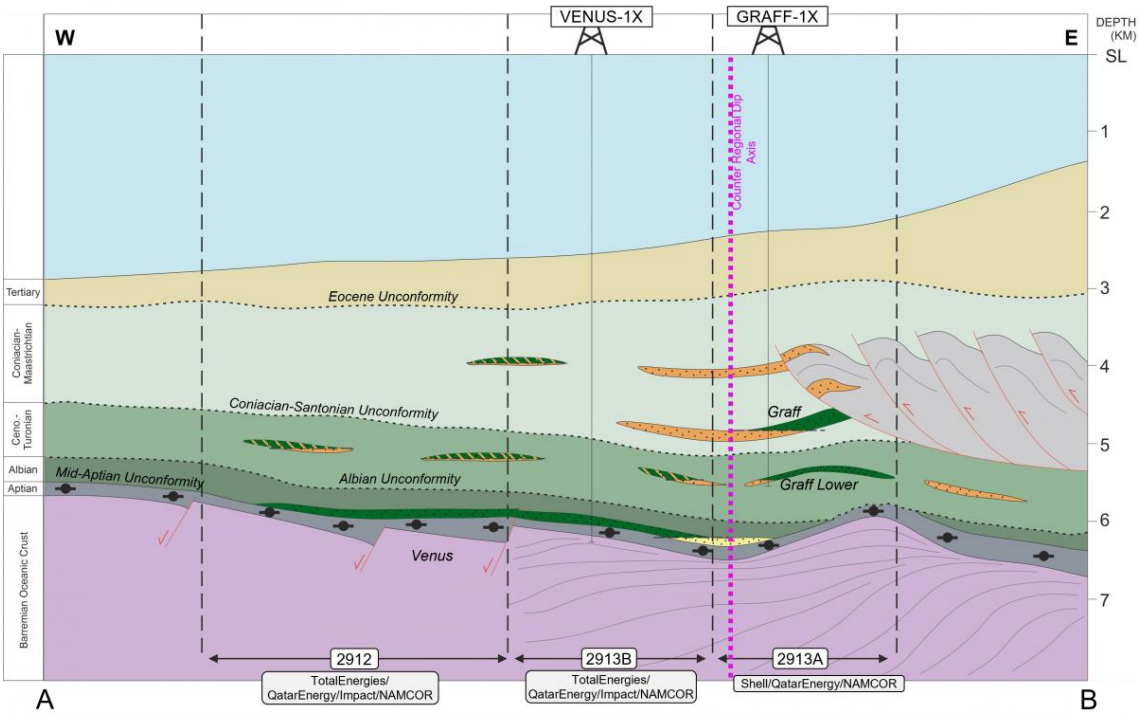

Figure 6. This diagram shows that there is significant upside within the Upper Cretaceous above the Venus-1X discovery. Also shown is the possible lateral extent of the oil found in Venus-1X. From: Impact Oil & Gas website, February 14, 2023.

Where Does This Leave the Kudu Gas Field?

For almost 50 years oil companies along with Namibia's energy officials wrestled with trying to make the Kudu gas field into a commercially viable operation. A key problem is that Kudu's contingent resources of 1.3 trillion cubic feet of gas are relatively small. Eight wells have delineated the Kudu gas reservoir. However, it is not a simple continuous marine sheet-sand, nor does it consist of attractive turbidity basin floor fan sands. Rather, the geology of Kudu is totally different from the deepwater discoveries made by Shell and TotalEnergies. The Kudu reservoir consists of Triassic-age aeolian (desert) sands interbedded with volcanics, mainly basalts. Kudu is 130 kilometers (80 miles) from the shore and the water depth is 170 meters (560 feet) which is operationally manageable. Operational challenges are that the reservoir is deep at 4,500 meters (14,760 feet) and the seas in the Kudu area can be very rough.

Namibia's government has always viewed Kudu as a nationally important project for Namibia. The plan was to have Kudu's gas pipelined to a proposed 475-megawatt gas-to-power electricity plant to be built near Oranjemund. Namibia suffers from an electricity deficit with diesel generators currently providing 30% of the country's grid-connected supply. Gas from Kudu would have replaced the high-cost diesel-burning generators. A dilemma was that there would have been too much electricity generated from Kudu to be consumed by Namibia's small population of only 2.5 million people. A large proportion of the population consists of subsistence farmers whose energy consumption is minimal. Excess electricity would need to have been exported to electricity-deficient neighboring countries like Zambia and South Africa which are faced with looming electricity shortages. Indeed, the overall region suffers from severe energy poverty.

Since its discovery by Chevron in 1974, development of Kudu has been bogged down due to issues related to reserves, commerciality, and ongoing negotiations with neighboring countries. Almost fifty years have passed since Kudu's discovery. Over the years, companies participating in Kudu have included Shell, Chevron, Texaco, Energy Africa and Tullow Oil.

However, the Kudu project may be finally moving. BW Energy is operator of Kudu with a 95% interest and NAMCOR has 5%. BW Energy is an Oslo, Norway-based company and is also involved in oil production offshore Gabon and Brazil. A deal has been struck by BW to buy a semi-submersible drilling rig that is set to be the hub of the gas-to-power project. The acquisition is part of a revamped development which could have BW also involved in the power generation aspects of the project. Recent indications from the Namibian government are that Kudu will likely receive government approval in 2023.

Nevertheless, the totally unexpected mega-oil and gas discoveries by Shell and TotalEnergies have completely up ended the government's views on Kudu. In the industry seminar in April 2022 to the Canadian Global Exploration Forum (CGEF) in Calgary, Namibian government officials explained that Kudu must now be viewed in context of the huge oil and gas discoveries made in Graaf and Venus. A wholistic Orange Basin gas development "road map" must be developed. Indeed, gas from the Graff field could be pipelined to Kudu and contribute as feedstock for the

powerplant at Oranjemund. With the gas suddenly found in Graff and Venus, Kudu could now be much more commercially viable. Basin-wide scenarios must be considered including exporting gas from the Orange Basin as LNG to gas-hungry markets in Europe and Asia.

Oil discoveries like Graff and Venus, if proven to development threshold, can be the catalyst to unlock the gas potential of projects like Kudu. This has been the model in West Africa for decades where oil discoveries were developed first and then gas discoveries were developed thereafter. Fast tracking of oil developments led to fast tracking of the gas. Nigeria's Bonny LNG project would not have happened without the initial oil developments. The same model applies to Angola's Soyo LNG project and to the smaller LNG projects in Equatorial Guinea and Cameroon. In every case oil is first and then followed by gas. A well-worn and proven path that works.

The Future

The Namibian government wants Shell and TotalEnergies to fast-track the Graff and Venus oil discoveries. IHS Markit hosted CERAWeek in Houston, Texas on March 7 – 11, 2022. Namibia's Minister of Mines and Energy, Tom Alweendo in a keynote speech said that the Namibian government wants the oil discoveries to benefit the Namibian people. He wants all Namibians to have access to affordable and reliable electricity. Due to Namibia's abundant wind and solar, he believes the country will also become a regional hub for green energy. Consideration will also need to be given for Namibia to eventually export green and gray hydrogen to markets worldwide.

Presently Namibia has made the development of hydrogen a priority and has a few hydrogen projects in progress. The **Hyphen Energy Project** is targeting the first production of green hydrogen by 2026 – 2027. Hyphen Hydrogen Energy (Pty) Ltd ("Hyphen") is a Namibian green energy development company. Hyphen's partners include UK-based Nicholas Holdings and Enertrag based in Germany. The estimated cost of this project is US$ 9.4 billion which is roughly equivalent to Namibia's annual GDP. This project will be in the uninhabited Tsau/Khaeb National Park. It will ultimately produce 300,000 tons per year of green hydrogen for regional and global markets, either as pure green hydrogen or as green ammonia. This green hydrogen is generated from this project's planned 5 GW of renewable energy capacity (solar and wind) and 3 GW electrolyzer. RWE Ag based in Essen, Germany will offtake the green hydrogen and ammonia at a planned terminal in Bnunsbuttel in Germany. The project once developed will employ an estimated 3,000 people of which 90 percent are expected to be Namibians. In their website, Hyphen states that it wants to play its part in helping Namibia show the world that Africa can help in powering the global energy transition. Hyphen states that this project is "pioneering the African Green Hydrogen revolution".

As previously mentioned, the total population of Namibia is 2.5 million people. Despite Namibia's significant mineral resources and tourist industry, Namibia is not a rich country. It had a per capita income in 2021 of only $4,865 per person compared to the USA's $70,480. In parts of the country

the economy is a subsistence farming economy with high rates of unemployment. Life expectancy in Namibia is only 63 years compared to 83 years for Canadians. The revenue and employment opportunities created by oil and gas production, if properly managed, will be hugely beneficial for Namibia. Indeed, Namibia is ranked as one of the most democratic countries in Africa (Reference: Transparency International).

In 2021, the Canadian explorer, ReconAfrica discovered oil in a totally unexplored sedimentary basin in northern Namibia. This led to high profile people like the American actor Leonardo DiCaprio and Prince Harry recommending that Namibia ought not develop the discovery due to the sensitive environment in northern Namibia. Others were also recommending that Namibia avoids developing an oil industry due to fossils fuels contribution to global warming. However, in my view this is rather hypocritical since are not Namibians entitled to good jobs and good incomes like those we enjoy in the developed world?

On February 24, 2022, Russia invaded Ukraine. This has much accelerated the world's need for stable and secure supplies of oil and gas. The discoveries in Namibia could help alleviate global shortages. All indications are that the oil and gas discoveries of the past two years will be transformational for Namibia's economy and people.

About the Presenter: Tako Koning is Holland-born and Alberta-raised. He was involved with the evaluation of the Kudu gas field when he was portfolio manager with Texaco in Luanda, Angola from 1995 – 2002. Shell was operator of Kudu and Texaco had a 15 percent working interest in the field. Since that time, he has had an abiding interest in Namibia's oil and gas industry and he closely follows the latest news coming out of the country. He has travelled a couple of times as a tourist in Namibia. The country is magnificent with its deserts, spectacular coastline, wildlife and numerous national parks He has a B.Sc. in Geology from the University of Alberta and a B.A. in Economics from the University of Calgary. He worked worldwide for Texaco for thirty years and subsequently he continued to work in Angola for Tullow Oil and the American/British consultancy of Gaffney, Cline & Associates. During his 45-year career, he lived and worked for 30 years in Indonesia, Nigeria, and Angola and 15 years in Calgary. He is pleased to share his knowledge of Namibia in this presentation.