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Analysis of today
Assessment of tomorrow

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Africa's gas—can it fill the gaps?

Rising transportation cost estimates, and rising delivered gas cost estimates, are changing the viability of five African pipeline proposals.

The Central Africa Pipeline/Ajaokuta–Kaduna–Kano (AKK) Pipeline

The pipeline tariffs inland to Ajaokuta and Kano are estimated at $0.60 per MMBTU and $1.20 per MMBTU, respectively. Such low costs are attainable because of the economies of scale coming from a 36-inch pipeline.

If the commodity gas were priced at or near the minimum wholesale price—quite likely given Nigeria's history of very low gas prices—the delivered gas cost at all points between Calabar and Kono would be $3.20 per MMBTU or less.

At this level, natural gas would compete extremely favorably with diesel, the alternative power generation fuel for these inland locations. Moreover, low-cost gas supply would open up possibilities for industrial gas demand as a complement to power sector demand.

Nevertheless, volume would appear to be the major challenge facing the CAP/AKK pipeline. A 36- inch pipeline would transport over 800 MMCFD of gas—enough to generate over 4,700 MW of power.

Although Kano, Abuja and other inland cities have significant populations that could eventually support such a level of demand, the weak industrial base in these cities makes rapid demand development a challenge.

The West African Gas Pipeline (WAGP) Expansion/Extension

Future generation additions in both Ghana and Côte d'Ivoire will be gas-fired, yet gas production from domestic sources will likely fall short of needs.

For Ghana, Nigerian gas delivered via WAGP is extremely attractive vis-à-vis liquid fuels or LNG. This would hold true even if the commodity gas price in Nigeria were raised to match the LNG netback.

An extension of WAGP to Côte d'Ivoire would also result in very competitive fuel supply

An extension of WAGP to Côte d'Ivoire would also result in very competitive fuel supply. Reliability of supply is the main issue standing in the way of expansion and extension of WAGP.

Deliveries to date have been far lower than expected because of supply shortages in Nigeria and accidents on the pipeline itself. As a result, neither Ghana nor Côte d'Ivoire views WAGP as a reliable supply source and both countries are seriously pursuing an LNG import option.

The Palma–Johannesburg Pipeline

The estimated pipeline tariff for this 36-inch pipeline from Palma to Johannesburg is $3.20 per MMBTU. This would result in a delivered gas cost of $5.70□ 10.90 per MMBTU, depending on how the commodity gas is priced.

The implications of these price ranges on the competitiveness of gas-fired power in South Africa must be studied. Given the size of the South African market, aggregating substantial power and nonpower demand volume seems feasible, and this could make a pipeline from Palma to South Africa an attractive proposition.

The Tanzania–Kenya Pipeline

Analyses of this pipeline concept create a planning challenge for Tanzania. The estimated pipeline transportation costs are low: $1.10 per MMBTU to Mombasa and $2.50 per MMBTU to Nairobi.

If commodity gas were priced at the minimum price, the delivered gas cost would be $6.80 per MMBTU in Mombasa and $8.6 per MMBTU in Nairobi, values that could be very competitive.

However, this situation is not seen as particularly realistic. Tanzania's gas resources are not unlimited, and exports to Kenya would probably be lower priority for Tanzania than LNG exports and domestic power generation demand.

To be competitive, exports to Kenya would need to be priced at LNG export parity. But this would result in delivered gas prices above $10 per MMBTU, which may render gas uncompetitive when compared against Kenya's other power generation options.

Tanzania Inland Pipeline

Demand in Shinyanga and Kigoma will not support a large-diameter pipeline, and the tariff for a 1,200km 16-inch pipeline would be very high. Providing energy to remote inland markets in Tanzania is likely to be far more efficient via power transmission lines.

The lower-cost transportation alternative

Of the five pipeline concepts, only the two Nigerian options show gas pipelines as the lower-cost transportation alternative. In the case of the inland CAP/AKK pipeline, this is because of the economies of scale coming from a 36-inch pipeline.

In the case of the WAGP expansion/extension, it is because the incremental cost of pipeline expansion is very low. If the full WAGP tariff were considered, pipeline costs would again be higher than power transmission costs.

Comparing the inland Nigeria route (CAP/AKK) with the inland Tanzania route is instructive. While the routes are similar in length, the volume of gas that is assumed to flow on the Nigeria pipeline is more than seven times that of the Tanzania pipeline.

Transporting gas will be the lower-cost option only if enough demand can be aggregated to support a 28-inch or larger pipeline

Modeling done for some studies suggests that for a 1,000 km distance, the breakeven energy load between AC power transmission and gas pipelines is roughly 3,000 MW.

In pipeline terms, this implies that transporting gas will be the lower-cost option only if enough demand can be aggregated to support a 28-inch or larger pipeline.

The Palma–Johannesburg route provides another interesting comparison between pipelines and transmission lines in the case where a large amount of energy is to be transported over a large distance.

The comparison between a 36-inch pipeline and a point-to-point DC transmission line shows a slight cost advantage in favor of power transmission.

However, such an analysis ignores the potential benefit of gas or power off-take at intermediate points along the route. The pipeline would emerge as the lower-cost alternative if compared either to an AC line or a DC line with multiple DC/AC inverters at points along the route.

The challenges for gas pipeline development in Sub-Saharan Africa

The five projects described above illustrate the challenges for gas pipeline development in Sub-Saharan Africa. In most cases, the markets are too small and the distances too great to make pipelines economically viable.

And the WAGP experience shows that even an economically attractive export project can founder unless every element in the gas value chain works as planned.

In most instances, the lowest-cost option for transporting energy from gas resource centers to markets will be via power transmission lines rather than pipelines.

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As a result, expanding the economic reach of gas-fired power more broadly in Sub-Saharan Africa will generally mean locating gas-fired power plants closer to gas production areas than to markets.

This solution is also likely to be the most efficient way of incorporating mid-merit, lower-load-factor gas generators into the energy grid. The flexibility of power transmission lines to move electricity from all types of generators (hydropower, gas, coal, renewables, etc.) further strengthens the case that they should be the primary avenue for regional energy integration in Sub-Saharan Africa.

The viability of the projects

Selected regional gas pipeline projects could go forward. New export pipelines from Mozambique to South Africa and from Tanzania to Kenya would seem to have a credible chance of aggregating enough demand to drive gas transportation cost down to competitive levels. And expanding and extending WAGP could be done for very low cost if improved supply conditions could be put in place.

Of course, the viability of these projects would depend ultimately on how the delivered cost of gas in the importing countries stacks up against other generation options. Nevertheless, many analysts think that the prospect of a continent-wide, interconnected gas pipeline system -- like that of the southern cone of South America -- seems very remote.

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The volume of gas that can be transported through a pipeline increases exponentially with the diameter of the pipe. In the engineering equations for pipeline flow, pipe diameter is raised to the power of 2.5, reflecting not just the increase in cross-sectional area as diameter increases, but also dynamic and frictional effects.

Pipeline construction costs, on the other hand, are usually considered to vary more or less linearly with pipeline diameter because the material costs of the steel line pipe itself are proportional to the circumference of the pipe.

Construction costs are also normally assumed to vary linearly with pipeline length. The linearity with respect to both diameter and length serves as the basis for rules of thumb for rough estimation of pipeline construction costs in terms of $/inch-km or $/inch-mile.

The combination of exponential volumes and linear costs leads to powerful 'economies of scale' in the unit cost of pipeline transportation. For example, increasing the diameter of a 1,000 km pipeline from 20 to 28 inches reduces unit transport costs by 40 percent.